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WORKSHOP ON ORAL AND DENTAL HEALTH RESEARCH MAY 3-5, 1978.(U)  
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WORKSHOP ON ORAL AND DENTAL HEALTH RESEARCH

MAY 1978

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Office of Naval Research, and  
Naval Medical Research and Development Command  
Bethesda, Maryland

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## I. INTRODUCTORY REMARKS

Captain James F. Kelly, DC, USN, Oral and Dental Health (ODH) Program Manager

### A. Objective of Workshop

To review the scientific and administrative aspects of the ODH program as a preliminary to developing specific program objectives and establishing criteria against which the program can be evaluated in the future.

B. Outline of remarks made by Captain Joseph D. Bloom, MC, USN, Commanding Officer, Naval Medical Research and Development Command (NMRDC), at an NMRDC Commanding Officers' Conference in April 1978.

### 1. Responsibilities of Research and Development Command

#### a. Acquisition of resources:

- (1) Fiscal
- (2) Personnel
- (3) Facilities

b. Definition of resources (including limitations). The resources should be tailored to the program and its objectives and requirements.

c. Coordination of programs.

d. Monitoring and auditing of programs.

e. Correction and repair of deficiencies that are identified within programs.

### 2. Role of Laboratories

a. The execution of programs.

b. The correction and repair of deficiencies identified within programs. These deficiencies should be corrected and repaired as a joint effort of NMRDC staff and laboratory personnel.

c. Participate in definition and planning of programs. There is a need for more emphasis of this particular role.

### 3. Methods whereby these functions can be coordinated.

a. Frequent Commanding Officers' conferences.

b. Frequent visits to laboratories by members of the NMRDC staff.

c. Personal review of programs by Commanding Officer, NMRDC.

d. Attendance at monthly personnel, fiscal and facilities briefings by NMRDC staff (and by Laboratory Commanding Officers, when possible).

e. Development of 1498 research proposals on the basis of program objectives.

f. Development of program objectives which lend themselves to audit and review.

g. Written documentation of the reasons for disapproval of 1498 work units, providing rebuttal mechanism for Commanding Officers. The final decision concerning such matters will reside with the Commanding Officer, NMRDC.

4. SUMMARY: The NMRDC should emphasize the following:

a. The proper management of people within NMRDC programs.

b. Maintenance of a balance of programs in relation to Naval and Marine Corp requirements.

c. Implementation of a master plan for a philosophy of management within NMRDC.



## II. MANAGEMENT REVIEW

### A. Naval Medical Research and Development Command (NMRDC) (Capt. Kelly)

1. Facilities. There are eight Laboratory Commands within the NMRDC (Table 1). ODH personnel are assigned to two of these laboratories and additionally to the National Naval Dental Center and the National Bureau of Standards.

2. Manpower. The manpower allocations within NMRDC are depicted in Tables 2, 3 and 4. This data reflects the relative distribution of personnel resources to the ODH program.

3. Fiscal. Tables 5-11 list funding data that is pertinent to NMRDC and the ODH program. Comparison of data in Exhibit 11 with that in Tables 8, 9 and 10 will provide an indication of the relative distribution of fiscal resources to the ODH program.

### B. Naval Dental Research Institute (NDRI) (Capt. Wirthlin)

1. History. The first "official" research project done by Navy investigators was at Great Lakes in 1947. This was an evaluation of the use of antibiotics for treatment of necrotizing gingivitis, and of the incidence of that acute disease. In the early years, many fine projects were undertaken with the collaboration of scientists such as Massler, Fosdick, Kesel, and others at the nearby universities. To the small military staff, civilian investigators were added, starting in 1952. New directions for research into dental operating room design and equipment evaluation in the mid-60's developed dental research at Great Lakes into a facility with an Officer-in-Charge status in 1967, and to a 3rd echelon Command under Bureau of Medicine and Surgery in 1969. In 1974, the Institute became one of the laboratories in the Naval Medical Research and Development Command.

2. Personnel. From its small beginning, the staff grew to its present size of 40 on board. Significant gains in the last seven years have been in U.S. Air Force Veterinary support, and an increase of five enlisted and five dental officers. In the near future the Institute expects to gain one training billet and two assistants for Clinical Investigations. Plans for FY80 are to acquire two more billets for the Dental Care Delivery Division.

The staff has earned 15 Doctoral, 9 Master and 12 Baccalaureate degrees, and has 4 dental officers trained for American Board certification.

3. Fiscal Status. The budget for FY 1978 is \$620K. Half that amount goes for independent research and facility support. Civilian salaries and benefits amount to nearly \$300K. With the military salaries, the Institute contributes over a million dollars to the local economy. The greatest effect on the fiscal history was in 1974 when the Institute relocated from Bldgs. 600 and 57-H to the spaces vacated by NAMRU-4. As a tenant of



NRMC, the Institute contributes 76% to utility costs for Bldgs. 1-H and 43-H. Special projects for utilities to serve a clinical wing, an animal colony, and habitability improvement have kept 6.5 funds higher than usual. Assets in Class III Plant Property amount to \$542,821.00.

4. Facility. The Institute occupies 40,195 square feet on the ground and first floor of Building 1-H, and a large part of Building 43-H adjoining on the North side.

In the Administrative Department there is a library of over 5,000 volumes, offices for reports and manuscript preparation, illustrations, fiscal and supply, and shops for dental repair, and glassware preparation.

The Scientific Department has laboratories for Histopathology, in which are done paraffin sections, histometrics, histochemistry and radio-autography, ultrasections, and transmission electron microscopy. The animal colony includes hamsters, rice rats, white rats, rabbits, and monkeys. The Microbiology Division deals with aerobic and anaerobic bacteria, and immunology. The Biochemistry Division uses special instruments, and organic and inorganic analysis methods.

The Clinical Investigation Department has conventional operatory spaces, backed up by central sterilizing, prosthetic laboratory and x-ray darkroom, as well as an open bay for evaluation of operatory configuration or equipment evaluation.

Within the geographic area the Naval Regional Dental Center and Naval Regional Medical Center have 112 dental operating rooms, 94 dental officers and 120 dental technicians. The average naval population is 21,000. However, there are transient populations of 36,000 naval recruits and 37,000 Service School students per year who can be surveyed.

5. Organization. The Institute is a 4th echelon command under the Naval Medical Research and Development Command, Bethesda, Maryland. The Command reports to the Commandant, Ninth Naval District for area coordination.

There are three Departments, each headed by a Director, to whom the Chiefs of Divisions report. Some Divisions are divided into Branches on a technical basis. This organization format allows for delegation of authority and decision-making to the lowest practical level, so that all the staff have an opportunity to develop executive skills.

Plans for FY80 are to divide the Dental Care Delivery Division into Branches for Dental Health Management and Facilities Support.

Cutting across the organization for the conduct of Work Units of RDT&E are inter-disciplinary teams headed by Principal Investigators. Associate Investigators are encouraged to participate in Independent Research projects so that they may achieve Principal Investigator status.

Through host-tenant agreement, there is a Protection of Human Subjects Committee staffed primarily by the Chiefs of Service of NRMG, Great Lakes, with Legal and Chaplain representation from the Naval Base.

6. Civilian Relationships. From its beginning, the Institute has been favored by close ties to scientists in the universities of the midwest and with the Research Institute and Dental Councils of the American Dental Association. Persons in the dental schools at Illinois, Northwestern, Loyola, Marquette, Indiana, and Southern Illinois University have been especially helpful.

Members of the staff have held high positions in the International Association for Dental Research and the Chicago Section of the American Association for Dental Research. NDRI staff have also contributed to and participated in their scientific programs.

NDRI consultants are recognized authorities in clinical and scientific disciplines, and span the United States in their location. The results are a great collaboration and lack of parochialism.

7. Program Management. The mission of the Institute is to conduct research, development, test, and evaluation in dental and allied sciences, with particular emphasis on problems of dental and oral health in Navy and Marine Corps populations and on problems of fleet and field dentistry. Specific functions are research relative to oral and dental health, with special emphasis on the recruit; and dental operator and equipment design under Navy and Marine Corps operating conditions.

With this mission in mind, the Institute staff participates in stating goals, developing strategies, identifying clinical problems and writing objectives to which our Work Units are directed. The goals are stated in terms of the ultimate benefit to the sailor or Marine, as rendered through the Navy Dental Corps. The strategies have four major thrusts to meet the defined goals:

- a. Control emergencies of painful incapacitating lesions of acute inflammatory diseases.
- b. Repair individual deformed structures of caries-mutilated teeth and loss of periodontal support, and to restore to function and esthetics the orofacial structure.
- c. Prevention of tooth and alveolar bone destruction and evaluation of methods in the user community.
- d. Develop improved dental health care delivery studies in naval dental facilities of operations and utilization of personnel.

The Program is set out with milestone objectives over the current and next four out-years. Priorities and progress are judged by precepts of relevance, competence, originality, quality, payoff, and achievement. Relevance is over-riding. A formal written review at the laboratory and Command level is accomplished yearly, with special consideration of funding (zero base budget concepts). There are currently 10 RDT\*E Work Units and 4 Independent Research projects.

C. Dental Sciences Department (DSD), Naval Medical Research Institute-  
(Capt. Cotton)

1. Administrative Structure. The Chairman, DSD, functions as the administrative and scientific director for the Department. The Chairman is one of 10 scientific department chairmen within the Institute. Currently, all scientific department chairmen are Navy Captains, PL-313's, or GS-15's. The department chairmen, acting collectively, constitute the Scientific Advisory Council (SAC) to the Commanding Officer. This group is responsible for the scientific review of all research work units, ensuring scientific merit and military relevancy.

The Chairman, DSD, reports to the Office of the Commanding Officer. Reporting to the Chairman are the Deputy Chairman, Senior Military Officer (who must be other than the Deputy Chairman), Administrative Assistant, and the Division Heads.

The Administrative Assistant occupies a military enlisted billet which reduces the available laboratory technical support. However, the importance of this position cannot be understated since each Department Chairman is designated a Cost Center Manager under the Resources Management System (RMS). The Administrative Assistant is responsible, with the Chairman, for developing the annual departmental budget, the departmental overhead rate, and the incremental expenditure of funds. Additionally, he assists and advises the Chairman in identifying and programming 6.5 resources for facilities and equipment needs.

One of the divisions within the Department is the Laboratory Sciences Division which provides support functions including histology, biochemistry, immunology, and limited microbiology. The investigators in this Division also conduct research in the 6.1 task area.

The Clinical Sciences Division is involved primarily in exploratory and development (6.2) and advanced development (6.3) research, applicable to the specialties of endodontics, periodontics, and oral surgery.

Currently, the principal investigator (PI) staff consists of 6 dental officers, including officers with expertise in periodontics, endodontics, immunology, histology, and oral surgery. There is one civilian PI (GS-11 Research Chemist) with expertise in biochemistry. The PI's are currently responsible for 7 work units and 2 independent research work units.

2. Enlisted Dental Research Personnel. The contributions of the DSD, NMRI, enlisted staff is more noteworthy when you are aware that we are authorized 5 NEC 8714 billets and yet have consistently been manned at 4 for the past 2 years. Our production has remained high in spite of the 20% reduction in manning. The Technician/Investigator ratio for the Department shares the distinction of having the lowest ratio with one other department within the Institute. In spite of the low ratio, productivity in the form of publications has remained relatively high.



I fully realize that the Navy is not currently manned at full authorized strength, therefore, I am not suggesting that we be manned to full strength. But, when essential billets, such as the Research Assistant Supervisor billet becomes vacant with no replacement, or the department falls below the 80% manning level, these are serious personnel problems which affect research programs and have required an inordinate amount of time to solve.

3. Fiscal Matters. The total Department funding has been adequate. However, within task areas it has been inadequate. In Table 15 it is seen that the bulk of the funds are in the 6.1 task area. This has created unbalanced funding in 6.1, 6.2, and 6.3. The unbalanced funding creates a management problem and complicates implementation of the Resources Management System (RMS). RMS requires that expenditures be directly identified with a work unit. Funding, like personnel, must be program directed.

4. Postdoctoral Research Associateships (PRA). The NMRDC has long sponsored a PRA Program in conjunction with the National Research Council. The Program is designed for postdoctoral investigators who have received their doctorate within 5 years immediately preceding commencement of their associateship. The incumbent receives a GS-11 appointment for 1 year. Salary and research funds are made available through independent research funds. Travel and moving expenses, within the U.S., are made available through work unit funds. For FY79 NMRI will receive 7 PRA's, one of which will be assigned to the DSD. He will be involved in research on mechanisms of bone repair. Besides the value to the incumbent, the PRA Program provides a means for identifying future permanent investigators for a specific research program.

D. National Naval Dental Center (NNDC) (Dr. Pelleu)

1. Organization. The National Naval Dental Center, Bethesda, Maryland, was established by the Secretary of the Navy through promulgation of OPNAV NOTICE 5450 of 25 June 1975. The Center is under the command and primary support of the Bureau of Medicine and Surgery. The Center is under the area coordination authority of Commander, Naval District, Washington. The Research Department of NNDC has two divisions:

a. The Planning and Development Division plans and administers all matters relating to research activities of the Research Department. Research activities include staff, graduate and resident projects. The division also provides instruction, supervision and guidance in graduate and resident research.

b. The Laboratory Division provides laboratory facilities and personnel to support the accomplishment of research administered through the Planning and Development Division. The division also provides instruction, supervision and guidance in graduate and resident research.

2. Functions. The Research Department of the National Naval Dental Center conducts research on NMRDC projects; coordinates all matters pertaining to research in dentistry and allied sciences; provides guidance of staff and student personnel in the use of statistics; assists members of

the staff with the presentation of courses in the basic sciences in educational programs as required; supervises all research projects of officers attending graduate programs; provides all scientific services incidental to these projects and maintains a materials testing laboratory and a histology laboratory.

3. Personnel.

a. The Chairman, Research Department, reports to the Director of Educational Services for educational matters, the Director of Clinical Services for clinical matters, and the Director of Administrative Services for administrative matters.

b. Staff of the Research Department consists of a Division MSC Officer and two Dental Technicians who report to the Chairman, Research Department, through the chain of command.

E. National Bureau of Standards (NBS) (CDR Whitlock)

1. Facilities. The National Bureau of Standards is located in Gaithersburg, Maryland. In addition to its commonly known work in establishing basic standards, the Bureau is heavily involved in other investigative programs ranging from computer sciences and technology to materials research. The Navy ODH program is conducted within the metallurgy division of the Institute for Materials Research.

2. Personnel. One dental officer and one dental technician are assigned to NBS. These investigators work in collaboration with the scientific staff of NBS, and through such cooperation are able to greatly facilitate their research efforts. In addition, the Navy investigators work closely with the members of the American Dental Association section of the Metallurgy division.

3. Fiscal. The fiscal support to the project at NBS is provided through a contractual arrangement with NBS, Department of Commerce. The level of funding is 20K per annum.



### III. SCIENTIFIC PROGRAM REVIEW

#### A. Naval Dental Research Institute (NDRI)

1. The goals of the research effort at NDRI are:

- a. Control urgent oral health problems
- b. Prevention of destructive oral diseases
- c. Development of improved dental care delivery

2. The major thrusts of the laboratory are:

a. Control emergencies associated with painful incapacitating lesions and acute inflammatory diseases.

b. Repair individual deformed structures of caries-mutilated teeth and loss of periodontal support, and restore to function and esthetics the oral-facial structure.

c. Prevention of tooth and alveolar bone destruction and evaluate methods in the community.

d. Develop improved dental health care delivery by studies in naval dental facilities of operations and utilization of personnel.

3. Following is an overview by the investigators at NDRI.

a. "Evaluation of Oral Factors in Decay-Free Naval Recruits to Develop New Preventive Measures" - B. L. Lamberts, PhD. The objective of this project is to evaluate oral factors that may be involved with the development of or resistance to decay. Knowledge of these factors could lead to new measures in preventive dental care of Naval personnel.

A longitudinal study of the presence of Streptococcus mutans in caries-free recruits is in progress. Eight of thirty originally caries-free subjects have been resampled to date and, of these, three have required occlusal restorations. However, more data on these organisms with respect to their numbers, location, and period of contact with tooth surfaces are required before their significance in relation to the incidence or prediction of human dental caries can be determined.

Bacterial glucanases are oral factors that could be potentially caries-protective, since they degrade streptococcal glucans. The prevalence of bacterial glucanases, including dextranases ( $\alpha$ 1, 6 glucanases) and  $\alpha$ 1, 3 glucanases, were determined in dental plaque samples from 19 caries-free and 20 caries-active subjects. Dextranase-producing organisms were found in all subjects, and there were no significant differences in their mean percentages out of total organisms counted for the two groups of subjects. Although no evidence of  $\alpha$ 1, 3 glucanases was found in these initial tests,

additional tests for these enzymes with more sensitive techniques are being implemented.

Several investigators have reported that salivary proteins and peptides, particularly a peptide designated "sialin", can promote oral pH-rise effects. We have begun the study of such factors in whole saliva of caries-free and caries-active recruits. Subsequent work will focus on parotid saliva proteins and partially-degraded salivary proteins, to determine whether certain salivary proteins or peptides may be protective in caries-free recruits, and have practical potential for clinical application in military populations.

b. "Evaluation of Fluoride Concentration in Plaque of Naval Recruits" - R. W. Gaugler, LCDR, MSC, USN. It has been known for some time that dental plaque accumulates large amounts of fluoride. The fluoride levels vary from 100 to several thousand times the levels in saliva, indicating that a binding action of some kind must be present. However, the way in which this fluoride is bound, and the role that it may play, or be led to play, in the prevention of caries is unknown. Recent studies have indicated that plaque can concentrate fluoride from dilute solutions, such as saliva or drinking water, and serve as a source of the fluoride incorporated into enamel under the plaque. It is possible that differences in the amount of fluoride taken up by the plaque, or in its availability at the tooth surface, may exist and play a role in the susceptibility of the individual to caries. These aspects of fluoride handling by plaque from caries-free and caries-active recruits are currently being examined. Two samples of posterior interproximal plaque from each individual are examined, one for its ability to take up fluoride from dilute solutions, and the other for the amount of fluoride extractable with water, cold dilute acid, and hot concentrated acid. Analysis will determine if any differences in fluoride handling exists which can be related to the caries status of the individual.

c. "Microbiology of Oral Diseases of Significance to Naval Personnel" - I. L. Shklair. Streptococcus mutans is considered to be the prime etiologic agent of smooth surface decay. The organism produces sticky, extracellular, water-soluble and insoluble glucans. The glucans help the organisms adhere to the teeth, as well as offer protection against the mouth's natural defenses and may keep the acid produced by the organisms in contact with the teeth. S. mutans isolated from caries-active recruits produce significantly more total glucans than S. mutans isolated from caries-free recruits. When six S. mutans strains, that synthesized varying amounts of soluble and insoluble glucans, were implanted into rats, the organisms that synthesized the greatest amount of insoluble glucans produced the most proximal caries. The amount of soluble glucans synthesized did not appear to be a significant factor in the caries produced in the rats.

Future plans include the isolation of S. mutans from caries-free and caries-active subjects and the amount of soluble and insoluble glucans determined in order to relate glucan production, particularly the insoluble glucans, with caries activity. A number of these organisms will be implanted into animals to further determine the role of glucan synthesis with caries

activity. In addition, compounds i. e., ionic detergents and low molecular weight dextrans, will be tested to determine their effectiveness in inhibiting glucan synthesis, particularly the insoluble glucans.

d. "Evaluation of Antimicrobial Agents on Disease Producing Organisms of the Oral Cavity of Naval Recruits" - I. L. Shklair. Dental caries is an infectious microbial disease and its initiation and development are associated with the presence of Streptococcus mutans. The objectives of this study is to develop specific therapeutic agents and measures for controlling or eliminating S. mutans from the mouth. Preliminary experiments indicated that repeated application of stannous fluoride (SnF<sub>2</sub>) with dental floss to posterior interproximal sites, was an effective but short-term measure for eliminating the organisms. In order for the SnF<sub>2</sub> to be effective in reducing or eliminating the organisms from the mouth, it should be applied in a greater concentration and for a longer period of time than was done in the earlier experiments.

In a current experiment eight volunteers were brought to a Class I dental condition. Five subjects were treated once with a 10 percent SnF<sub>2</sub> solution applied with Super Floss to all their posterior interproximal teeth. In almost all of the subjects, the numbers of S. mutans isolated from the treated sites were much lower than before treatment. The three control subjects did not vary significantly in the percentage of sites infected with S. mutans during the 8-12 month test period.

In the future, subjects will be treated with a SnF<sub>2</sub> gel. In addition, follow-up studies on the effectiveness of the SnF<sub>2</sub> treatment in preventing decay can be studied.

e. "The Prevention of Tooth Destruction by Low Molecular Weight Dextrans" - CDR R. G. Walter, DC, USN. The ability of S. mutans to produce extracellular polysaccharides allow the bacterium to stick to culture vessels, wires and teeth. However, work with mutant S. mutans, which produce greatly reduced amounts of water-insoluble polysaccharides, causes less caries in rats and demonstrates reduced adhesion to glass or wire surfaces.

Investigations conducted in our laboratory of differences between caries-active and caries-free naval recruits has centered on the association of S. mutans within the two test groups. During the course of these studies, it was noted that the S. mutans isolated from the caries-free recruits seemed to produce less extracellular polysaccharide than those isolated from the caries-active subjects. Further experimentation was conducted to determine if there were differences in glucan production between the two groups of isolates. The results indicated that the most active glucan synthesizers and the greatest percentage of active glucan producers occurred in the caries-active recruits. In addition, when the microorganisms isolated from the caries-free subjects are compared to those of the caries-active, there seems to be a trend which indicates that the caries-free subjects harbor S. mutans which produce less insoluble polysaccharide than do the S. mutans from the caries-active subjects.



The ability of low molecular weight dextran (T-10, M.W. -  $1 \times 10^4$  to act as an inhibitor of insoluble polysaccharide production and thereby prevent the formation of dental caries will be tested in both the golden Syrian hamster and the Osborne-Mendel rat animal models.

The *in vitro* glucan production assay described by Walter, Shklair and Lamberts will be used to determine the influence of 0.01% and 0.001% low molecular weight dextran on the production of insoluble glucan by various cariogenic streptococci. This assay allows for the separation of the total glucan into soluble and insoluble components. It will be used to determine the effect of small percentage of low molecular weight dextrans on each of the polysaccharide varieties.

f. "Evaluation of Methods to Degrade Components of Dental Plaque Associated with Oral Diseases of Naval Personnel" - L. G. Simonson. Many studies have indicated that oral health could be improved by dental plaque control. Our research efforts have been primarily concerned with enzymatic methods of plaque control. We have tested and evaluated specific enzymatic preparations for their potential oral therapeutic properties. Dextranase has been found to reduce or control dental caries in many animal studies. We have found a dextranase that has a high affinity for tooth surfaces and is capable of preventing the adherence of certain cariogenic streptococci onto these surfaces. We have attempted to further increase the affinity of this dextranase for hydroxyapatite by covalently binding it to a carrier phosphoprotein. This would theoretically prolong the dextranase activity on the tooth surfaces. We are presently investigating the optimal conditions for modifying this dextranase by bridging reagents with various molecular specificities.

Other studies involve the search for additional hydrolytic enzymes which will further degrade insoluble cariogenic plaque components. We have found a suitable microbial source of  $\alpha 1,3$ -glucanase in a compost sample. This enzyme coupled to dextranase could result in the complete hydrolysis of the adhesive glucans which many workers consider important in oral diseases. We also plan to locate suitable microbial sources of enzymes which would prevent the colonization of certain oral actinomycetes which have been implicated in periodontal disease.

g. "Evaluation of Therapeutics for the Prevention of Oral Destruction in Navy and Marine Corps Personnel" - E. P. Leonard, CDR, DC, USN. The ultimate objective of the research in the laboratory of Histopathology is to provide Navy dentistry with a proven, effective alternative to present methods of prevention for supporting structure disease with emphasis on the acute and sub-acute disease seen in the young recruit. The first major goal is to identify those chemotherapeutic agents or delivery methods which, under strictly controlled conditions, prove to be safe and effective in reducing plaque formation, gingivitis, and most importantly, destruction of supporting dental structures.

To date experimental data has been collected from 375 animals including base-line specimens, experimental groups and their corresponding controls. Plaque-degrading enzymes, both penicillium-derived and fungal dextranase were found to be ineffective in reducing gingivitis and periodontal bone loss, regardless of concentration or delivery methods employed. Chlorhexidine compound (HIBITANE) applied to the teeth in a two percent swab five times a week, was found to reduce both the amount of plaque accumulation and the amount of alveolar bone loss.

Groups of animals are currently on experiment to test the effectiveness of disphosphonates and non-steroidal anti-inflammatory drugs. Due to the demonstrable success with the anti-microbial chlorhexidine, a major effort will be directed toward evaluating different permutations in the delivery of this compound.

h. "Isolation of Anaerobic Microorganisms from Naval Personnel with Acute Periodontal Disease" - E. Mueller, LCDR, MSC, USN. Bacteria have long been suspected of playing an active role in the development and maintenance of acute disease of the dental supporting structures. Changes in population size, composition and actual invasion of healthy tissue beyond necrotic zones have been demonstrated by electron microscopic studies of lesions associated with acute necrotizing ulcerative gingivitis (ANUG). Rapid clinical improvement of patients suffering from ANUG when treated with penicillin, vancomycin, metronidazole and other antibiotics also implicates bacteria as agents in the etiology of this disease. Attempts to cultivate the flora associated with ANUG have met with mixed success. Morphologically distinct groups of spirochetes have been observed within ANUG lesions, but cultivation of all types observed has not yet been accomplished. Lack of required enrichments, degree of anaerobiosis for incubation, inhibitory factors within media and sampling technique inadequacies have all been proposed to account for failure of spirochetes of all types observed microscopically to grow.

It is the intent of this research to cultivate and identify spirochetes associated with ANUG. An anaerobic chamber has been erected and equipped for this study. Development of media, sampling devices and enrichment materials are underway. It is also desired to examine the characteristics of pure cultures of spirochetal isolates by gas chromatography, biochemical properties and electron microscopy. Immediate benefits of such goals are readily apparent. Identification of etiologic agents of ANUG will provide insights for treatment and will eliminate the need for "blind" therapy. It is also a prerequisite for prevention that the causes of this disease be understood. Definitive plans cannot be implemented until understanding of ANUG is more complete.

i. "Clinical Evaluation of Methods for Detection and Treatment of Incipient Carious Lesions in Naval Recruits" - J. W. Galich, LT, DC, USN. The purpose of this study is to develop and evaluate methods for the detection and treatment of the incipient carious lesion. If these lesions can be



diagnosed and treated in such a manner that they are arrested or reversed, and if this treatment can be provided by a dental technician, the impact on Navy dentistry would be such that the future increment of decay would be reduced and dental officer utilization would be more efficient.

The study is composed of three stages: 1) laboratory phase - for development of a dye system which will detect incipient carious lesion in vitro; 2) clinical phase - for evaluation of dye system in vivo; 3) clinical phase - which entails one year trial for evaluation of detection and treatment methods.

Various dye materials are being evaluated. Thus far, sodium fluorescein has provided the most promising results when combined with ultra-violet light. Stage II of the study is currently in progress, with Stage III to begin shortly.

j. "Evaluation of Expedient Procedures for Treating Dental Pulp Disease in Naval Personnel" - D. M. Anderson, CAPT, DC, USN, and G. E. Clark, CDR, DC, USN. Caries-related diseases such as pulpitis and periapical abscess were the most common causes of dental sick call emergencies occurring among Navy and Marine Corps personnel in Vietnam. This would indicate that our diagnosis and treatment methods for dealing with caries-induced chronic pulp disease are unreliable for the prevention of future emergencies.

The choice of pulp protection and treatment is usually left to the general dentist restoring the tooth. Carious lesions which encroach closely on the dental pulp pose a treatment dilemma for dental officers at Navy recruit dental clinics, where the condition is most commonly encountered. If pulp exposure occurs during cavity excavation, the dentist is left with three choices in lieu of extraction: first, direct capping, an unreliable procedure recently implicated as a cause of protracted pulp necrosis and ultimate abscess; second, pulpotomy, considered to be only a palliative, temporary treatment fully-developed permanent teeth and tested as a definitive technique only in isolated case reports; and third, root canal filling, which has a high success rate, but is very exacting, time-consuming and costly.

The indirect pulp cap is another alternative, but this option must be taken before cavity excavation is completed. It is a technique used extensively in dentistry to avoid pulp exposure in deep carious lesions. However, this is a two-appointment procedure, with an intervening time period to allow pulp healing and deposition of reparative dentin before final excavation is completed. This technique is not practical in recruit clinics because the training period is too short to allow the necessary treatment interval.

Therefore, our goal is to develop simple, innovative techniques with which the Navy general dentist can reliably treat caries-induced pulpitis

and restore lost tooth structure in the same visit. Additionally, we intend to establish diagnostic criteria for determining which diseased pulps are amenable to conservative treatment.

Present research efforts are divided into four phases:

(1) Correlation of clinical symptoms and diagnostic tests with the histologic evaluation of pulp disease. Comprehensive clinical data is gathered for deeply carious teeth designated for extraction to establish criteria for differentiating between reversible and irreversible pulpitis.

(2) Evaluation of techniques and materials presently used in the treatment of deep caries at recruit dental clinics. This is accomplished by means of pre-treatment exams, recording of treatment data and annual post-operative exams. We are currently obtaining one year recall examinations.

(3) Development of techniques for treating deep carious lesions in one appointment. The most promising treatment method is a modification of the indirect pulp cap. To justify leaving a thin layer of affected dentin in situ permanently, any remaining bacteria and their toxins must be rendered innocuous. Studies are directed toward isolating and identifying bacterial products in carious dentin which are toxic to the pulp. A component has recently been isolated which induces vascular permeability in rabbit skin. It will be tested for its effect on dental pulps of primate teeth. The source of the toxin will be determined and its route of ingress to the pulp will be traced. A method to inactivate this component will be developed. Any other toxic components isolated from caries will be investigated in a similar manner. Any agents developed to render the toxic components harmless would be incorporated into the indirect pulp capping regimen.

(4) Clinical trials utilizing the most effective techniques and materials gleaned from Phases II and III. Teeth will be selected for treatment according to diagnostic guidelines established in Phase I. Three or four clinicians will administer treatment for deep caries according to a specific protocol of techniques and materials in a well-controlled longitudinal study.

k. "Evaluation of Naval Oral Health Programs" - M. R. Wirthlin, CAPT, DC, USN. The overall purpose of this unit is to improve the management of manpower and fiscal resources caring for dental health programs, so that the Navy Medical Department can fulfill its role in the health care and fitness for combat of Navy and Marine Corps personnel.

With clinical, epidemiological, dental public health, statistical, and data processing methods we gather data base information on dental and oral health profiles, with emphasis on the recruit.

The prevalence of oral diseases in naval recruits is being determined from data gathered throughout the year (Tables 12, 13). Files are set up and annual recall examinations are sought to update the files, and to assess the incidence of new lesions.

This work unit is able to acquire data in format suitable for ADP processing and to develop treatment needs, useful to managers from the clinic to Corps levels. With program review, we add evaluation to the planning and implementation of the managers. Cost/benefit ratio and cost-effectiveness are new ways we evaluate clinical success. In the out-years this work unit will take on as community demonstration projects, the new treatment and preventive schemes developed by dental research.

In the future, we hope to perfect our cost evaluations, especially in treatment times and overhead areas; develop ability to work with older populations than the naval recruit; learn to predict those high-risk subjects who could impair naval missions; and relate dental and oral health to personnel effectiveness in the Navy and Marine Corps.

1. "Evaluations of Dental Implants as Applied to Navy and Marine Corps" - J. E. Yeager, CAPT, DC, USN. The purpose of this project is to determine which dental implants, if any, can be used safely and effectively in treating Navy and Marine Corps personnel. In efforts to accomplish the project objective, both innovative devices and commercially available products have been evaluated.

The thrust of this work unit to date has been to identify biocompatible materials and evaluation of implant design now in progress.

The materials study was a comparative evaluation of vitreous carbon, surgical grade ticonium, acrylic and aluminum oxide used as functional dental implants in 8 adult monkeys (*M. fascicularis*). Surgical grade ticonium and vitreous carbon were found to be superior to aluminum oxide and acrylic as dental implant materials.

The implant design study is scheduled for completion in the fourth quarter of FY78 and has as its purpose the evaluation in 8 adult monkeys (*M. fascicularis*) of an odontoid device (vitreous carbon) and a blade-vent implant (surgical grade titanium). Findings to date suggest that these two commercially available implant types have good potential for application in human reconstructive procedures.

Other studies that have been conducted in laboratory animals within the scope of this project have given support to the general work plan of determining which dental implants are most feasible for use in treating Navy and Marine Corps personnel.



In looking ahead to FY79, when planned long-term evaluations in human subjects are to be initiated, some events of the past 5 years which are relevant to the possible future use of dental implants in routine Navy dentistry should be considered. The events can be summarized as follows:

(1) In 1973, the Chief, Dental Division, Bureau of Medicine and Surgery, directed that until further notice, dental implants would not be used in Navy dentistry except in approved research projects.

(2) In 1974, 1975 and 1976, the Council on Dental Materials and Devices of the American Dental Association went on record in opposition to use of endosseous implants in routine dentistry. Continuing scientific review was recommended.

(3) In 1976, endosseous dental implants were categorized by the FDA under Public Law 94-295 as Class III devices - those medical devices that are yet to be proven safe and effective.

In the out-years, our plans for implant research must take into account changes in position of the FDA; the Council on Dental Materials and Devices of the ADA; and the Chief, Dental Division, Bureau of Medicine and Surgery.

m. "Wound Healing of the Supporting Tissues of the Teeth of Naval Personnel" - E. B. Hancock, CDR, DC, USN. The purpose of this study is to establish the biologic events which occur in the supporting dental tissues during the healing of accidental or surgical wounds so that patients with supporting tissue disease or trauma can be treated and placed on a health maintenance basis.

These studies comprise investigations into soft tissue healing, the diseased root surface, and the developing dento-gingival junction. Standardized gingival wounds, developed and tested in animals will be used to test treatment methods. The wounds will be analyzed biochemically for collagen content and histometrically to determine the hard and soft tissue relationships. The tooth root surface in healthy, diseased, and treated areas will be subjected to chemical analysis, and changes in morphology noted. Methods to make the diseased root surface biologically acceptable will be tested. Clinical evaluations will include an evaluation of probing as a non-invasive method for assessment of the attachment level, rupture strength of healing wounds and determination of the presence and timing of new cementum formation.

These investigations will identify those treatment methods which are biologically acceptable and most likely to result in the formation of a connective tissue new attachment. In the out-years promising methods will go to clinical trial in humans.

There have been several significant accomplishments to date. Standardized gingival wounds of linear incision and partial excision have been developed and tested in miniature swine. The position of the tip of the periodontal probe in normal gingiva was found to be within epithelium coronal to the cemento-enamel junction. The probe position in chronically inflamed and in healing gingiva is being evaluated. The diseased root surface was found to be hypercalcified, confirming earlier reports. A pilot work is underway to evaluate the use of a common bile salt, sodium desoxycholate, and a plasma protein, Cohn fraction IV<sub>1</sub>, to degrade and detoxify endotoxins on the diseased root surface. Pilot work to develop chronic periodontal defects in primates is progressing.

In the out-years, laceration wounds and lacerations with alveolar fracture will be evaluated in primates. Conventional and innovative treatment effects on diseased root surfaces in primates will be evaluated using the standardized wound of partial excision. Those treatment methods which are promising, safe, and biologically acceptable will then be subjected to clinical trial in humans in FY81.

B. Dental Sciences Department, Naval Medical Research Institute (DSD/NMRI)

1. Laboratory Sciences Division (Captain Turner)

The Laboratory Sciences Division, DSD/NMRI, has been assigned the mission of giving scientific laboratory support to research projects currently under investigation in the Clinical Sciences Division of the department.

The two areas in which the Laboratory Sciences Division has been actively engaged are (1) the employment of immunological criteria for the assessment and evaluation of various kinds of bone graft preparations, and (2) the study of the biochemical and biological phenomena underlying bone healing.

The experimental protocol for the assessment of graft preparations involves the placement of fresh, fresh-frozen and freeze-dried allogeneic bone preparations into surgically created defects in the mandibles of beagle dogs. At two-week intervals after graft placement, the recipient animals are tested for evidence of immunological response to donor tissue antigens. The rationale for this study is based on the finding that good correlation exists between intensity of immune response and graft rejection. Two tests are used to measure immune response: (1) antibody dependent, complement mediated cytotoxicity, and (2) lymphocyte dependent cytotoxicity.

The studies pertaining to mechanisms of bone healing involve animal models in which bone physiology is aberrant. The capacity for bone resorption is lost in these animals and the marrow cavities of the long bones are filled with osseous tissue. The condition is known as osteopetrosis and several rodent strains are affected. In most the defect is due to a



genetic mutation which is expressed as a homozygous-recessive characteristic.

This model is pertinent to the study of bone healing and physiology because the cellular basis for the defect has been discovered in experiments utilizing these animals. An hypothesis which has been gaining in acceptance is that the cell responsible for resorption in bone modeling, the osteoclast, is derived from a precursor cell which can also differentiate into a mononuclear leukocyte. Since the mononuclear leukocyte is involved in immune responses and in phagocytic activities, we are currently studying specific biochemical and immunologic properties of leukocytes isolated from osteopetrotic rodents.

It is the goal of this study to detect specific defects in these cells in order that our understanding of the mechanisms of bone healing will be more complete. It is projected that knowledge in this area will lead to a rational basis for measures which will enhance bone healing in clinical situations.

## 2. Clinical Sciences Division

### a. Investigations to Evaluate Osteogenic Materials and Osseous Regenerative Techniques (CDR Mellonig)

(1) Osteogenic Profile Study. An investigation to obtain a complete profile of the bone forming abilities of allografts, autografts, and composites thereof is well underway. These grafting materials are being evaluated in a unique animal model system which provides for both radio-nuclide and histologic techniques to be performed on the same sample.

The bone grafting materials are placed in porous nylon chambers and then implanted into defects created in the calvaria of guinea pigs. At specific time frames, the animal is injected with strontium 85. The incorporation of the nuclide into the matrix of new bone is quantified and subsequently prepared for histologic evaluation. The rate of new bone formation, as well as the total growth achieved, is being quantified. Freeze-dried bone allograft, decalcified freeze-dried bone allograft, autogenous osseous coagulum, autogenous bone blend, and autogenous marrow and cancellous bone are the graft materials under investigation.

After identifying the spectrum of osteogenic ability, the graft materials will be compared to human primates. Presently, it appears that decalcified freeze-dried bone allograft has an accelerated rate of new bone growth. This is further enhanced by combining this allograft with autogenous material. It is anticipated that the results from these experiments will afford the clinician a means of choosing one graft material over another with some degree of predictability.

(2) The Effect of Different Particle Sizes of Freeze-dried Bone Allograft on the Rate of Bone Growth. Presently, fine particles (100 - 300 $\mu$ ) of freeze-dried bone allograft are being used in clinical bone grafting procedures on an empirical basis. Calvaria defects in guinea pigs were used to evaluate the influence of particle sizes from 1-1000 $\mu$  on the growth rate of freeze-dried cortical bone allografts. Quantitation was achieved with the uptake of new bone and histology. The data from radionuclide uptake suggests that there is no difference in the growth rate or amount of new bone achieved with particle sizes ranging from 125-1000 $\mu$ . However, particle sizes below 125 $\mu$  may actually be inhibitory either because they prevent revascularization or are so rapidly resorbed that they are not replaced with new host bone. Histologic evaluation will confirm or refute these findings.

(3) Histologic Evaluation of Freeze-dried bone Allografts in Periodontal Osseous Defects of Baboons. The purpose of this experiment is to obtain histologic documentation whether or not new attachment is possible with freeze-dried cortical bone allografts of a small particle size. In addition, the antigenicity of freeze-dried bone when used as a grafting material to reconstruct bony defects about the teeth is also being evaluated. Contralateral intrabony defects were created by the method of Caton and Zander in baboons. The defects were implanted and the animals sacrificed to yield time frames of 2 weeks to one year. Clinical documentation was achieved with photographs, radiographs, and pocket measurements. Histologic material of the grafted sites will be evaluated for length of the junctional epithelium, presence of new bone, cementum, and periodontal ligament and will be compared to the non-grafted side.

It is felt that such documentation is needed either to corroborate or refute the clinical data presently available. This will have major clinical implications, as freeze-dried bone allografts are routinely used in periodontal osseous regeneration techniques both in the military and civilian communities.

b. Oral and Maxillofacial Surgery (Captain Triplett)

Oral and Maxillofacial Surgical Research at NMRI is directed towards finding solutions to clinical problems. This research focuses primarily on combat casualty care. Over the past 9 years a long term casualty survey has been carried out in relation to maxillofacial casualties suffered in the Vietnam conflict. This work has broadened our perspective of casualty treatment and is the basis from which current and future research efforts are directed.

Chronic infection was the most common postoperative complication seen in maxillofacial casualties. These infections were responsible for delayed healing and prolonged hospitalizations. To find improved treatment methods for this disease, an animal model (rabbit) for osteomyelitis

in the mandible has been developed. Following establishment of mandibular osteomyelitis the animals are treated with hyperbaric oxygen at 2 atmospheres.

The efficacy of this treatment is being evaluated and may prove to be a useful clinical method of treatment.

Hypovolemic anemia has been documented in both maxillofacial casualty patients as well as patients undergoing elective maxillofacial surgical procedures. Studies are being conducted to determine if this traumatic anemia delays osseous repair and, if so, to what extent. Bone grafts are performed in the mandible of beagle dogs. The experimental groups are depleted of 40% of their blood volume and maintained at approximately this level for an 8 week period. Healing is evaluated in both control and experimental groups using radionuclide imaging technique developed at NMRI.

The prostaglandins have been implicated as possible mediators or direct causes of bone resorption in dental disease and trauma. Prostaglandin E2 is being instilled in a non-invasive manner to the apex of incisor teeth in beagle dogs to determine if these drugs can cause resorption in vivo. If resorption is seen in response to prostaglandins, methods of blocking these drugs may be useful in preventing and curing bone loss in dental disease.

Probably the most neglected area in management in maxillofacial war wounds is psychological support. No existing program recognizes this as an area of concern and there has been no investigation to determine the extent of psychological trauma. From the casualty study, we have come to realize that there may be psychological problems related to maxillofacial wounds and long term care. We are, therefore, undertaking to determine what, if any, modification of psychological well-being is associated with maxillofacial injuries and if it is different from other war injuries.

c. Research Effort in Pulp Biology (LCDR Cunningham)

A study categorizing the dental emergencies occurring in Navy-Marine personnel in Vietnam demonstrated that approximately one-half of the emergencies were caries-related (defined as all conditions resulting from caries such as pulpitis, periapical involvements, and painful carious lesions). Despite our treatment, the same problems that the serviceman brings with him into the service are also the primary cause of the dental emergencies that are encountered in the operational field. This is further complicated by the fact that our present treatment procedures may indeed cause immediate or delayed pulpal emergencies.

(1) Current projects in the 6.2 area of pulp biology research include:

(a) "Freeze-dried Bone as a Potential Pulp Capping Agent." A reliable agent which will induce healing and closure of pulp

exposures by the formation of a calcified barrier is not yet available. Because of its known ability to induce calcified tissue formation, freeze-dried bone (FDB) is being investigated as a potential pulp-capping material. Freeze-dried bone will be placed in mechanically created pulpal exposure sites of animals by a standardized technique in order to evaluate its effectiveness when compared to the commonly used direct pulp capping agent, calcium hydroxide.

(b) "Effect of Temperature on the Tissue-Dissolving Ability of Sodium Hypochlorite." Previous studies have shown sodium hypochlorite to be an excellent endodontic irrigant. The purpose of this study is to investigate the effect of temperature on the tissue dissolving property of this irrigant drug. Dissolution rates of multiple samples of preweighed bovine tendon collagen will be determined in two concentrations (5.2% and 2.6%) of sodium hypochlorite at two different temperatures (21°C and 37°C).

(2) Current project in the 6.3 area of pulp biology research:

"Pulpal Response to Restorative Procedures as Applied During Dental Treatment in Naval Personnel." Acid etchants enhance the bonding of composite restorative materials to enamel, but attempts to bond to dentin have been unsuccessful. Nevertheless, acid etchants are commercially available as cavity cleansers for direct application to dentin to remove debris after preparation of the cavity. Investigation was performed to evaluate the effect of citric acid cavity cleanser alone on the human dental pulp when applied to freshly cut dentin. Another study will evaluate the effect of a cavity drying agent on the pulp. Should this material prove to be non-toxic to the dental pulp, it can be assumed that it will not be a contributing factor to the incidence of dental emergencies in Navy and Marine Corps personnel, and can be recommended as a safe, expedient, and cost-effective treatment material for use in restorative dentistry.

Studies projected for out-years include: (1) the use of FDB as a pulpotomy agent; (2) the use of FDB as an agent to induce apical closure; (3) the effect of FDB and calcium hydroxide on periapical tissue; (4) the use of collagen-calcium phosphate gel in pulpotomy and pulp-capping; (5) the use of surface tension depressants to improve the spread of endodontic irrigants; (6) the effect of pH on the germicidal properties of sodium hypochlorite; (7) effect of temperature on the germicidal properties of sodium hypochlorite; and (8) studies on dentin etchants to enhance bonding of composite to dentin.

C. National Naval Dental Center (Dr. Pelleu)

1. Major Thrust.

Preliminary Evaluation of New Dental Materials, Equipment,



Drugs, and Procedures for Naval Dentistry.

The research program of the National Naval Dental Center is presented with regard to current accomplishments and anticipated future direction in the following categories:

a. Prevention of Tissue Destruction

- (1) Decontamination studies of a microbial and chemical nature.
- (2) Toxicity studies on various endodontic materials.
- (3) Efficacy of various plaque removal methods.
- (4) Evaluation of treatment methods for Herpes Labialis
- (5) Clinical evaluation of freeze-dried bone allografts in treatment of infrabony periodontal defects.

b. Materials Investigations

- (1) Factors affecting the bonding of procelain to non-precious alloys.
- (2) An evaluation of alloy casting techniques
- (3) The properties of composite resin restorative materials.
- (4) Other miscellaneous studies.

2. Research Units

a. Prevention of Tissue Destruction

- (1) Decontamination studies -- Microbial
  - (a) The efficacy of various medicaments in the decontamination of root canals.
  - (b) Disinfection and sterilization of dental materials and instruments.
  - (c) Evaluation of methods for reducing the number of airborne bacteria in dental operating rooms (DOR's).

- (2) Decontamination studies -- Chemical
  - (a) Evaluation of methods for reducing mercury vapor in DOR's.
  - (b) Factors affecting airborne beryllium concentrations in dental spaces.
  - (c) Evalaution of methyl methacrylate vapor levels in Navy dental laboratories.
- (3) Toxicity studies on various endodontic materials
  - (a) Histologic response of rat connective tissue to zinc-containing amalgam.
  - (b) Procion labeling of osteogenesis in rats following calcium hydroxide implantations in maxillary alveolar bone wounds.
  - (c) Cell-mediated, humoral, and chemotactic responses to endodontic cements.
- (4) Efficacy of various plaque removal methods
  - (a) Clinical evalaution of a single-tufted toothbrush for plaque removal.
  - (b) Clinical evaluation of the "Swab Tip" as a subgingival plaque control device.
  - (c) Clinical evaluation of flossing aids for the reduction of Streptococcus mutans in interproximal areas.
- (5) Evaluation of treatment methods for Herpes Labialis
  - (a) The use of water soluble bioflavonoid-ascorbic acid complex in the treatment of recurrent Herpes Labialis.
  - (b) Serum and stimulated parotid salivary IgA in patients with history of Herpes Labialis.
- (6) Clinical Evaluation of Freeze-dried bone allografts in treatment of infrabony periodontal defects.
  - (a) Clinical evaluation of freeze-dried bone in periodontal osseous defects - Parts I and II.
  - (b) Clinical evaluation of freeze-dried bone allografts used in combination with autogenous bone in periodontal osseous defects.

b. Materials Investigations

(1) Factors affecting the bonding of porcelain to non-precious alloys.

(a) An evaluation of four variables affecting the bond strength of porcelain to non-precious alloys.

(b) The effect of various abrasive dental stones on the surface quality of a non-precious metal utilized in ceramometal restorations.

(2) An evaluation of alloy casting techniques.

(a) The effect of vacuum-pressure casting techniques on marginal adaptation of base metal alloys.

(b) The physical properties of repeatedly used non-precious metal alloys in fixed partial denture castings.

(c) A comparative study of removable partial denture frameworks utilizing the vacuum-casting and centrifugal techniques.

(3) The properties of composite resin restorative materials.

(a) An evaluation of commercial pastes for finishing composite resin surfaces.

(b) An evaluation of the porcelain-composite bond strength in the repair of fixed partial dentures.

(c) A comparison of retentive adaptation of composite resins inserted by a plastic instrument and a Centrix C-R syringe.

(d) Cavity preparation for composite resin: An in vitro assessment of microleakage using <sup>45</sup>Ca.

(e) A comparison of resin restorative systems for marginal microleakage when using the acid-etched technique.

(f) The effect of threaded pins on the shear strength of Class IV acid-etched composite restorations

(g) A study of gap formation in teeth restored with composite resins.

(h) A study of filler particles in composite resins.

(4) Miscellaneous Studies

- (a) Calcium hydroxide as a root canal filling material-
- (b) The effects on microleakage of intermixing intermediary base materials and resinous cavity varnish.
- (c) Sealing properties of double composition high-copper dental amalgam alloys.
- (d) An evaluation of marginal leakage in spherical high-copper alloys.

D. National Bureau of Standards (NBS) (CDR Whitlock)

The present Navy/NBS research activity was established as a four year program and designed to examine the feasibility of using non-precious alloys for fixed dental castings. Early work in the program was concentrated in the specific area of castability and accuracy of fit of castings made from various precious and non-precious alloys.

Continued refinement in investment techniques has led to non-precious alloy castings which are consistently oversize (acceptable) and which demonstrate acceptably smooth surfaces.

Examination of the coefficients of expansion of six commercially available bonding porcelains has been undertaken to identify the differences in these dimensional characteristics which exist between the various frits. Similar dilatometric measurements are being gathered for eight dental alloys. Based on these data, "couples" of compatible porcelains and metals are fused together, tested for bond strengths and compared with the previous data for correlation.

Continuing examination of the "fusion zone" between porcelain and metal will include:

1. The study of composite porcelain/metal specimens to ascertain the effects of one component on the other with regards to their contraction coefficients.
2. Investigation of the wetting characteristics of fused porcelain on metal substrates as related to various alloy surface preparations.
3. Observation of the thermal conductivity characteristics of porcelain/metal composites.



#### IV. DISCUSSION: CURRENT PROBLEMS

##### A. Personnel.

The personnel resources of NMRDC have been documented in Table 4. As of July 1978, NMRDC will have on board a Command Master Chief who will be responsible for the coordination of enlisted personnel matters. He will serve as liaison between NMRDC, BUMED and BUPERS. Currently, there are not enough NEC 8714 (Dental Technicians, Research) in the system to permit development of a reasonable plan of rotation. Recruitment has been a problem, although the reasons are not clearly defined. Undoubtedly, contributing to the problem is the question of opportunity for advancement in rate. Specialty personnel are not tested on their specialty knowledge, and have not always had an opportunity for appropriate sea-shore rotation. The in-service training program for 8714's at our laboratories could be improved. A plan of rotation should be developed so the technicians have the advantage of career planning that includes operational assignments. The Command should prepare the technicians for their operational assignments as well as for advancement in rate. Via the Command Master Chief, the content of the advancement in rate examinations, as it relates to specialty groups in the dental technician ratings, should be discussed with the appropriate individuals in BUPERS. In the absence of 8714's we should recruit 0000's for utilization in such areas as clinical investigation. All enlisted billets should be reviewed with the Command Master Chief to determine training requirements and facilitate development of an enlisted master career plan for the ODH program.

The number of officer and enlisted personnel billets for and assigned to the program will be dependent on the strength of the program within NMRDC and the medical department. If the program is relevant, scientifically sound, productive and visible, we should have little trouble programming for and attracting personnel.

There is a need for better promotion opportunities for medical service corps officers in the allied science field. The apparently poor opportunities that exist for promotion has a very negative effect on morale.

Based on anticipated losses to the ODH program through retirement, there will be a shortage of dental officer investigators within two to three years. This situation is more acute than it appears because of the need to initiate training of officers for research well in advance of the anticipated need. The ODH training requirements for fiscal years 1979 through 1985 have been identified to NMRDC, (Table 14). It will be necessary to actively recruit in order to meet these requirements. Included in the potential recruitments option are: recruiting visits to naval facilities, recruiting visits to universities with research institutes and/or reserve dental programs, advertising in appropriate professional journals, wide publication of the results of Navy dental research, and continued sponsorship of the dental clerk programs at our laboratories.

The objectives of the ODH program and the work plans for out-years will have to be carefully stated and updated annually in order to assure the availability of appropriate personnel to perform the work and accomplish the objectives.

The post-doctoral research associateship (PRA) program has been initiated within the Dental Sciences Department at NMRI as part of the overall NMRDC program. This program could also serve as a source of future investigators within the NMRDC-ODH program. It is anticipated that this program will be considered for implementation at NDRI in the near future. There is a buyer's market for the recent postdoctoral graduate. The Navy's ODH research laboratories offer an ideal setting for the recent graduate with dual DDS, PhD degrees. However, the postdoctoral investigator, like any investigator, must fulfill the research program requirements of the Navy. He cannot be left in a laboratory to do his own thing. Once the postdoctoral investigator is attracted to the Navy and proves himself as a capable investigator, then we should be prepared to make some degree of commitment to the individual. Foreign shore or sea duty may be part of that commitment, and this is, in fact, desirable, but we must be competitive with academic institutions. If we are to make a commitment to a research program then we must also be willing to make a commitment to a potential research investigator who plans a career in research. It has been a long established policy that the Navy provide training for dental officers to enter research. It is not productive or cost-effective to train dental officers for all our research needs when the "buyer's market" is available. By the time an officer achieves the PhD he is too senior to function at the postdoctoral level and too inexperienced in research to function in a scientific leadership position. The training of dental officers for research careers should selectively continue, but at the same time we must attract recent postdoctoral graduates to a Navy research career.

#### B. Facilities.

The Dental Sciences Department at NMRI will be renovated as part of a master plan for that institution. It is anticipated that, following the renovation, the Dental Sciences Department will occupy a wing of the Institute. This renovation will have to be coordinated carefully with program and personnel objectives for the out-years.

There is considerable interest, within the NMRDC, in developing a large research center in San Diego sometime in the future. At the recent NMRDC Commanding Officer's conference the possibility of relocating NDRI was discussed. It was pointed out, by Captain Kelly and Captain Wirthlin, that if such an option were seriously considered that it be with the understanding that NDRI would remain as a Command, as this was of great significance to the integrity of the ODH program within NMRDC. Any further discussion of such a proposal will be carefully monitored by the Commanding Officer, NDRI, and the ODH program manager, and coordinated with those codes within the Dental Division that would need to be involved for planning. It was recognized that the most significant factor that would precipitate the

need to relocate would be the discontinuation of recruit training at Great Lakes. The effect of relocation on both Military and Civilian personnel was discussed as well as the opportunities for scientific collaboration that exists at Great Lakes versus San Diego and Southern California.

### C. Fiscal

The fiscal profile of NMRDC and the ODH program have been presented in Tables 5 - 11.

Contract research supported by NMRDC has not been used as a means of augmenting the ODH program. A limited number of contracts have been supported by ONR, when such investigations have had relevance to the Navy mission and ODH program. If, as a result of facilities or personnel limitations, certain segments of the ODH program require extramural supplementation, the utilization of contracts will be considered. It is not anticipated that such contracts would ever constitute a very significant portion of the ODH program.

The level of support for the ODH program is not considered adequate for the objectives of this highly relevant Navy research effort. An example of the disparity in support can be appreciated when a comparison is made of the Dental Sciences Department (DSD) of NMRI with the other nine departments of that Institute in various indices of support versus productivity for FY77. DSD had the lowest ratio of technicians per investigator (NMRI range; 1.00 to 2.88; DSD: 1.00), the second lowest level of funding per publication (NMRI range: 34.8K-320.1K; DSD: 34.9K), and funding per research proposal (1498) (NMRI range: 24.9K-84.2K; DSD: 38.8K). On the other hand, DSD had the third highest ratio of publications per investigator (NMRI range: 0.22-2.63; DSD: 1.43), and publications per 1498 (NMRI range: 0.15-1.38; DSD: 1.11). The Department has the second lowest level of funding within NMRI (NMRI range: 324.7K-1600.0K; DSD: 349.3K).

The total program funding for Navy biomedical research for FY72 was 21,857K, of which the ODH program was 559K or 3%. In FY78 the Navy biomedical research program funding was 28,771K, of which the ODH program had 659K, or 2% (Table 10). In the period FY72 to FY78 the ODH program funding was decreased 1%, while the total Navy biomedical research program was increased 32%. This support is unacceptable for an effort as productive and relevant as the ODH program.

The NMRDC laboratories are expected to manage their fiscal resources by incremental programming. If reprogramming of funds is necessary, it must (and can) be accomplished through NMRDC. It is desirable to identify the need for reprogramming as early as possible in the fiscal year.

Independent research funds are available to be used to support work that is innovative and for which regular 6.1 funds are not available. Independent research projects may extend into a second year and/or be continued as a regular 1498 submission.



There is a possibility of receiving funding in the 6.4 category (Engineering Development) during FY79. NDRI will be submitting a proposal for work in this area to include a range of development problems that have been raised by the operational forces. Dental officer billets to support this work will need to be assigned to NDRI.

#### D. Programmatic Issues

A historical review of where oral and dental health research fits into the DDR&E Technology Coordinating Paper (TCP) was considered. The first TCP (1971-1972) placed dental diseases in the Infectious Diseases Chapter, since these diseases are caused primarily by streptococci. Caries, periodontal disease and other soft tissue disease, including pulpal and mucosal infections, were treated in the Chapter under the general sub-heading of Dental Disease. Thus, dental diseases did not stand alone as programmatic elements. In the 1971-1972 TCP, Oral and Maxillofacial Injury (OMI) was placed separately from Dental Disease under the chapter entitled "Traumatic Injury and Surgical Casualty Management" and also appeared in the 1977 update. Other dental disease research does not appear as a distinct research program in the 1977 TCP update.

The Science and Technology Objective Document (STO) is another programmatic publication that identifies, at the Chief of Naval Operation level, the science and technology thrusts for the Navy. There are three priority levels assigned to each problem - critical, high priority, and priority. Oral and Dental Health is assigned a priority rating and becomes the enabling document for driving all oral and dental health research within the Navy. The STO, then, identifies the Navy problem, which, in turn, becomes the driving document for the DDR&E-DOD Technology Coordinating Paper. It should reflect the needs of oral and dental health research. The TCP, then, should be the ultimate enabling document, since it is a Tri-Service Coordinating Document signed off by the Assistant Secretary of Defense for health affairs. It is anticipated that the next TCP, and its associated supporting documents will accurately reflect all of the Navy's oral and dental health research programs.

The caries research that supports the unique requirements of the Navy must be strongly identified with the Navy populations that it serves. The importance of the program to seek methods to treat and control an almost universal disease in this age population cannot be overstated. Justification of relevancy of the program is based upon:

1. Lack of dental standards for entry into the Navy.
2. Caries is the most common reason for dental treatment in this population.
3. The increase in caries incidence in recruits after entry into the Navy.



4. Manhours spent within the Navy to treat the disease.
5. The most frequent cause of dental emergencies in the battlefield (Vietnam) are caries related.
6. Available manhours cannot provide all caries treatment needed to avoid emergencies.
7. The population is unique in that other agencies, including NIH, are not involved with research to prevent and treat the disease in this age group.

The unique features of the recruit population that requires the Navy's interest in caries research are:

1. NIH programs are primarily directed toward research in prevention of caries in children.
2. The development of a caries preventive vaccine by NIH is not directed toward a preventive vaccine for the age of the recruit population.
3. Vaccine, for Navy use, must be developed to interfere with the existing bacteria and their attachment to teeth, whereas vaccine for children may be directed against prevention of the initial establishment of the bacteria in the mouth.
4. Other preventive measures - fluoride treatments, mouthrinses, topical medicaments, etc. - being investigated by NIH are directed toward the child population, therefore, not specifically applicable to the Navy population.

The Navy's OMF Program requires clear identification also. Separation of the Army and Navy's program must be clearly delineated in the TCP. While the objectives stated in the current TCP are the same for both services, the work units are distinctly different. The Army is meeting the objectives primarily by investigating non-biologic materials (plastic, ceramics, alloys, etc.), while the Navy is investigating biologic materials (freeze-dried bone and skin, tissue grafts, etc.).

#### E. General Issues.

One of the strongest defenses of the ODH program will be the continued development of sound epidemiologic data concerning Navy and Marine Corps populations. LCDR James C. Cecil, DC, USN, will be reporting to the NDRI staff in September, following completion of a PhD program in Public Health at the University of Michigan. It is anticipated that Dr. Cecil will provide an opportunity to broaden and improve the epidemiologic efforts in all segments of the ODH program.

Program development and monitoring is essential to good research management and will be emphasized by NMRDC. The ODH program will be developed on the basis of objectives that relate to the operational requirements of the Navy. These objectives will be monitored against specific criterion statements that will serve as a basis for determining the success or failure of meeting the objectives. The objectives and criterion statements for the ODH program will be presented in Section V of this report.

The research work at NNDC and the Bureau of Standards has been very successfully conducted during the past several years. Levels of funding have been adequate and the cooperation and support at both facilities has been excellent.

The opportunity for developing a research effort at one of the NMRDC overseas laboratories has been entertained. At this time, it would seem that the most likely location would be the Naval Medical Research Unit #3, Cairo, Egypt. Work at an overseas laboratory would, of course, have to be relevant to Navy problems. Such an effort would provide investigators within the ODH program an opportunity to have an overseas assignment that would permit them to continue research activities within the unique environment of the overseas laboratory. This initiative will be pursued in the near future.

Dr. Arthur B. Callahan, of the Office of Naval Research, was unable to attend the Workshop because of illness. The support that ONR provided to the Workshop was greatly appreciated.

The Workshop was characterized by open and frank discussion, and the results of the deliberation should serve as a very useful reference for the management of the ODH program.

V. ORAL AND DENTAL HEALTH PROGRAM: GOALS, OBJECTIVES AND CRITERION STATEMENTS

A. ORAL AND DENTAL HEALTH PROGRAM MANAGER

The program of ODH research within the Navy must be productive of results which are relevant to Navy dentistry and can be applied to solutions of the problems of clinical practice. In order to determine that satisfactory results are forthcoming from the ODH program, a list of program goals, objectives and criterion statements have been developed for NDRI and DSD, NMRI. Achievement of the goals and objectives at these facilities will be judged against the stated criteria. In this way the effectiveness of the ODH program can be determined in a more objective manner, and management decisions can be developed less empirically.

This is a first attempt at developing goals, objectives and criteria for the ODH program. During FY 1979 an objective refinement meeting will be convened, at which time this list will be reviewed, updated, and modified as necessary. The appropriate frequency of future meetings will be determined at the time of the FY79 review.

As this is the first attempt to apply this method of program assessment to the ODH program, the goals, etc., have been developed only for the efforts at NDRI and DSD, NMRI, as the work at these facilities seems to be best suited for evaluating a method of this type.

B. NAVAL DENTAL RESEARCH INSTITUTE

1. GOAL 1 - Control Urgent Oral Health Problems

Goal 1 is that the active duty serviceman in the Navy and Marine Corps will suffer no diseases, disabilities, or injuries of the teeth, jaws and related structures, which directly or indirectly interfere with the performance of his military duties because of pain, disfigurement, lack of satisfactory oral function, or threat to general health, and that the health care will be responsive to his felt needs.

The program objectives are to control emergencies of painful and incapacitating lesions of acute inflammatory diseases; repair individual deformed structures of caries-mutilated teeth and loss of periodontal support; and to restore masticatory function and facial esthetics resulting from loss of teeth.

a. Evaluation of Expedient Procedures for Treating Dental Pulp Disease in Naval Personnel.

Objective: To reduce the incidence of acute pulpitis from caries-related injury.

Criterion Statements:

FY79 - The permeability factor toxin from carious dentin will be purified and characterized. The toxin will be tested in primate teeth

for pulpitis induction and its route of ingress through dentin.

FY80 - Organisms found in human caries will be surveyed for production of permeability toxin and methods for elimination of the micro-organisms will be developed.

Develop and evaluate anti-permeability toxin agents in rabbit skin, tissue culture, and primate teeth.

Human carious dentin will be assayed for other toxic components.

FY81 - Clinical trials of anti-toxin agents will be initiated in carious lesions.

FY82 - Continue clinical trials of anti-toxin agents.

FY83 - Complete clinical evaluation, and disseminate information to clinicians of the efficacy of anti-toxin agent to reduce the incidence of pulpitis in carious teeth.

b. Isolation of Anaerobic Microorganisms from Naval Personnel with Acute Periodontal Diseases.

Objective: To reduce the incidence of acute inflammatory periodontal disease and thereby control emergencies of painful and incapacitating lesions.

Criterion Statements:

FY78 - Develop equipment, media and clinical sampling techniques for strict anaerobes in the mouth.

FY79 - Isolate cultures from humans with necrotizing gingivitis and identify the spirochetes and their antibiotic susceptibility.

c. Evaluation of Expedient Procedures for Treating Dental Pulp Disease in Naval Personnel.

Objective: To evaluate a conservative, one-step restoration of caries-mutilated teeth to reduce the incidence or progression of impending pulpal infection.

Criterion Statements:

FY79 - Evaluate diagnostic criteria which will best identify diseased dental pulps which are amenable to conservative therapy.

Begin clinical trials of the most efficacious materials and methods for the treatment of deep caries.



FY80 - Continue to collect long-term recall data on conservative treatment of deep caries.

FY81 - Report results of controlled clinical trials of conservative pulp treatment after long-term recalls, demonstrating the efficacy of methods and materials.

d. Wound Healing of the Supporting Tissues of the Teeth of Naval Personnel.

Objective: To repair individual deformed structures in naval personnel by obtaining a new attachment reconstitution of the periodontium subsequent to pockets and wounds associated with gingival inflammation.

Criterion Statements:

FY77 - Standardized wounds of simple incision and flap will be developed and tested for objective assessment.

The use of the periodontal probe will be evaluated as a non-invasive method of attachment documentation.

FY78 - Standard wounds of simple incision and flaps will be made in primates and the healing analyzed by clinical, histometric and biochemical methods.

The effect of conventional treatments on diseased root surfaces will be evaluated by chemical and fibroblast viability methods.

The development of pockets in primates will be standardized.

FY79 - Wounds of laceration will be made in primates and the healing analyzed by clinical, histometric and biochemical methods.

The effect of innovative treatments on diseased root surfaces will be evaluated by chemical and fibroblast viability methods.

FY80 - Wounds of laceration and simple alveolar fracture will be made in primates and the healing analyzed by clinical, histometric and biochemical methods.

Using a standard flap wound system, conventional and innovative treatment of diseased root surfaces will be evaluated in primates with pockets and new attachment documented.

FY81 - Wounds of laceration and comminuted alveolar fracture will be made in primates and the healing analyzed by clinical, histometric and biochemical methods.

Clinical trial of conventional and innovative treatment effects on the diseased roots of humans will be begun, using a standard wound system.

FY82 - The clinical trial will continue and the new attachment documented in each subject.

FY83 - The clinical trial will be completed and significant results reported to compare conventional and innovative methods of obtaining new attachment of the supporting tissues of the teeth of naval personnel.

e. Evaluation of Dental Implants as Applied to Navy and Marine Corps Personnel.

Objective: To restore function and facial esthetics in naval personnel with insufficient teeth for mastication of service ration.

Criterion Statements:

FY79 - Initiate long-term clinical trial in humans of dental implants.

FY80 - Continue trial of implants, documenting function and health of the supporting tissues.

FY81 - Continue trial, reporting significant short-term results.

FY82 - Continue trial, reporting mid-term results.

FY83 - Complete clinical trial in humans of dental implants and report long-term results of documented success for improvement of function.

2. GOAL 2 - Prevention of Destructive Oral Diseases

Goal 2 is that Navy and Marine Corps personnel will enjoy a lifetime of health and attractive appearance of the oral structures. These health benefits can be realized from early diagnosis which discriminates incipient or slightly involved lesions at the reversible stage and from available rational, highly effective and personally acceptable preventive measures.

The program objectives are to prevent destruction of tooth and alveolar bone tissues.

a. Evaluation of Methods to Degrade Components of Dental Plaque Associated with Oral Diseases of Naval Personnel.

Objective: To degrade components of plaque, thereby controlling the adhesion and accumulation of pathogenic microorganisms for the prevention of tissue destruction.

Criterion Statements:

FY79 - Continue development and testing of carrier-coupled enzymes to prevent adherence and caries activity of S. mutans in rodents.

FY80 - Test coupled and unaltered alpha-1, 3-glucanohydrolases for therapeutic effects in rodents.

FY81 - Evaluate combinations of enzyme preparations for prevention of dental caries in rodents.

FY82 - Test most optimal enzyme preparations from previous studies on primates.

FY83 - Evaluate toxicity of effective preparations and test in human volunteers, documenting the significant plaque reduction and oral health improvement.

b. Microbiology of Oral Diseases of Significance to Naval Personnel.

Objective: To prevent the formation of plaque by the control of adhesion and accumulation of pathogenic microorganisms for the prevention of tissue destruction.

Criterion Statements:

FY79 - Test (soluble and insoluble) glucan production of bacteria from caries-free and caries-active recruits. Test isolates for caries activity in rodents. Preliminary screen compounds as blocking agents against glucan synthesis.

FY80 - Evaluate compounds as blocking agents against glucan synthesis.

FY81 - Test anti-glucan synthesizing agents in animals.

FY82 - Test anti-glucan synthesizing agents in humans.

FY83 - Continue clinical testing of anti-glucan synthesizing agents and compounds for controlling the organisms involved in dental and oral disease, documenting the effect on clinical health and the prevention of tissue destruction.

c. Evaluation of Oral Factors in Decay-Free Naval Recruits to Develop New Preventive Measures.

Objective: To evaluate individual measures of improving host resistance for the prevention of tooth destruction by improving innate structure by systemic means.

Criterion Statements:

FY79 - The prevalence of bacterial glucanases and the levels of sialin, a salivary tetrapeptide promoting salivary pH rise effects, will be compared among caries-free and caries-active recruit populations. The evaluation of partially degraded salivary protein fractions, particularly for basic proteins, will also be initiated, following the methods used for evaluating sialin.

FY80 - The evaluation of partially degraded salivary protein fractions will be completed. The levels of secretory IgA, acting specifically against strains of *Streptococcus mutans*, will be compared among caries-free and caries-active recruits to determine the potential applicability of specific IgA as a caries-protective factor.

FY81 - Salivary antibacterial factors, which may include IgA, protease, salivary lactoperoxidase, or other oral agents disclosed during FY79 and FY80 will be evaluated, using comparisons of caries-free and caries-active recruits as criteria.

FY82 - Practical procedures will be developed and implemented to acquire the oral factors found to be most effective during the investigations conducted between FY77 and FY81, for in vivo tests in animals.

FY83 - Tests of the most promising factors will be conducted in primates. Initial clinical tests will be conducted in human volunteers.

d. Evaluation of Fluoride Concentration in the Plaque of Naval Recruits.

Objective: To improve effectiveness of fluorides to fortify surface structure by external means, improving host resistance and the prevention of tooth destruction.

Criterion Statement:

FY79 - Determine the uptake and binding of fluorides from solutions into the plaques on teeth of caries-free and caries-active naval recruits.

e. Evaluation of Antimicrobial Agents on Disease Producing Organisms of the Oral Cavity of Naval Recruits.

Objective: To evaluate antimicrobial agents for the inhibition of infection, metabolism or growth of pathogenic microorganisms for the prevention of tooth destruction.



Criterion Statements:

FY78 - Evaluate short-term results of S. mutans control by delivery of  $\text{SnF}_2$  with absorbent floss to proximal surfaces of selected human volunteers.

FY79 - Evaluate long-term results of S. mutans control and report the effect on infection of proximal surfaces in humans.

FY80 - Initiate large scale trial of dental caries control in naval recruit population.

FY81 - Continue trial of caries control in a naval recruit population.

FY82 - Complete trial and report the reduction of posterior proximal caries attack rate in naval recruit population.

f. Evaluation of Therapeutic Agents for the Prevention of Oral Bone Destruction in Navy and Marine Corps Personnel.

Objective: To evaluate systemic and antimicrobial agents that inhibit infection, metabolism and growth of pathogenic microorganisms in the periodontal pocket for the prevention of alveolar bone destruction.

Criterion Statements:

FY79 - (1) Evaluate the effect of diphosphonates with EHDP and  $\text{Cl}_2\text{MDP}$  on the progression of oral bone loss in periodontal disease. (These drugs must reduce the amount of bone loss as compared to controls.)

(2) Identify anaerobic microorganisms which are potentially pathogenic in periodontal destruction. (These microorganisms must be consistently recoverable from the diseased periodontium.)

FY80 - Evaluate the effect of anti-inflammatory drugs in-damethacin and salicylate in preventing alveolar bone destruction. (To be effective these drugs must reduce the observable destruction over a given period of time.)

Report the comparative effectiveness of all delivery methods and chemotherapeutic agents tested to date.

FY81 - Evaluate permutations in the delivery of chlorhexidine to prevent periodontal disease in the model. (Comparisons must be made in the methods of delivery, i.e. swabbing vs oral irrigation.) (Comparisons must be made to test the effectiveness of chlorhexidine in conjunction with fluoride administration.)

Conduct toxicity and tumorigenicity studies in the true Swiss albino mouse (chlorhexidine compounds must be tested for potential hazards and side effects).

FY82 - Initiate clinical trials of the most effective chemotherapeutic agent delivered via the most effective delivery method in human subjects.

FY83 - Continue clinical trial of chemotherapeutic agent, documenting results in each subject.

g. Detection and Treatment of Incipient Dental Caries.

Objective: To prevent the dental decay process from reaching an irreversible state by the early detection and treatment of incipient dental lesions.

Criterion Statements:

FY77 - Laboratory evaluation of various chemical indicators of incipient dental caries. Chemical indicator must vividly mark incipient lesions for visual detection.

FY78 - Clinical evaluation of chemical indicators of incipient lesions, Indicator must enable clinician to easily identify incipient lesions without permanently staining oral tissues or being toxic to the patient. Begin clinical trial of burnishing Stannous Fluoride into incipient lesions as a method of treatment.

FY79 - Complete 12 month clinical trial of selected methods for detection and treatment of incipient carious lesions. Selected method must significantly reduce increment of decay.

3. GOAL 3 - Development of Improved Dental Care Delivery

Goal 3 is that Navy and Marine Corps personnel should have access to a system which is responsive to their felt needs, is prompt and efficient in recognizing and providing their treatment requirements by methods demonstrated to be safe, effective and acceptable in facilities which are clean, comfortable, and professional in all aspects.

The program objectives are to improve dental health management in facilities operations; improve manpower effectiveness by Dental Technician/Assistant utilization; evaluate dental care such as preventive treatment programs; and to protect from hazards of cross-contamination and other environmental hazards associated with dental materials and devices, and dental facilities and practices.

a. Evaluation of Navy Oral Health Programs.

Objectives: To improve the management of dental health and evaluate dental care programs by design and analysis of a system to handle the flow and retrieval of dental information, showing services needed and provided, and the effect of preventive treatments.

Criterion Statements:

FY77 - Design of a new form familiar to dental personnel but which allows acquisition of dental information by mark sense will be begun.

Current methods of plaque control instruction in Navy clinics will be evaluated for significant effects.

FY78 - A new dental form evaluation will be completed and the overall information and retrieval system will be designed.

Performance problems in plaque control instruction will be analyzed and a new skill teaching program will be initiated for testing.

FY79 - The prototype form scanner will be developed and the system tested on a small unit of naval personnel.

The evaluation of a new program of plaque control instruction for naval recruits will be completed and significant results reported.

FY80 - The prototype system development will be completed and the total system will be tested on an operational unit.

A new preventive measure, such as use of  $\text{SnF}_2$  delivered by Super Floss will be evaluated in a recruit population.

FY81 - The dental information system will be used in evaluating the status of oral health and preventive programs in recruit populations.

A new preventive measure, such as use of salivary buffers, will be evaluated in a recruit population.

FY82 - A new preventive measure, such as use of modified glucanase enzymes will be evaluated in a recruit population.

b. Navy Dental Technician Utilization.

Objective: To improve the productivity of dental clinics by evaluating the DO/DT/DOR manning which provides cost-effective staffing.

Criterion Statements:

FY78 - Construct an intramural program for training endodontic auxiliaries.

Conduct developmental trial of DO/DT/DOR ratios in endodontics.

FY79 - Evaluate productivity of various DO/DT/DOR combinations for endodontics.

FY80 - Construct intramural programs for training periodontic auxiliaries. Conduct developmental trials of staffing and operating room ratios in periodontics.

FY81 - Evaluate productivity of various DO/DT/DOR combinations for periodontics.

FY82 - Construct intramural program for training operative dentistry assistants.

FY83 - Conduct developmental trials of DO/DT/DOR manning in operative dentistry.

c. Dental Equipment Development and Evaluation for Fleet Health Care.

Objective: To evaluate dental equipment and devices and to develop innovations which will support unique requirements of naval dental operations afloat and in the field.

Criterion Statements:

FY79 - A laboratory and prototype development shop will be equipped and staffed. The performance of sterilizable dental high speed hand-pieces will be tested.

FY80 - A compact, rugged and useful dental operating light for use in field operations will be developed. A new shelter for field dentistry will be developed and tested.

FY81 - A new panographic x-ray will be developed which is useful in evaluating high risk subjects for dental infections.

FY82 - The collection and elimination of particulate matter and exhaust gases from dental laboratories will be developed to prevent harm to health by environmental hazards from dental materials and devices.

FY83 - Sterilization equipment and practices will be developed to prevent harm to health by cross contamination in naval dental facilities.



C. DENTAL SCIENCES DEPARTMENT, NAVAL MEDICAL RESEARCH INSTITUTE

1. GOAL 1 - Oral and Maxillofacial Combat Casualty Care

Goal 1 is to develop more effective means for preventing and treating oral and maxillofacial combat casualties.

The program objectives are:

To shorten the period of rehabilitation by more precisely delineating problem areas, outlining treatment programs and defining treatment objectives for the various types of injuries;

To develop improved methods of hard and soft tissue management predicated on biological data developed from laboratory and clinical studies;

To develop improved methods of operative and post-operative management which will lessen systemic and wound complications; and

To develop improved preventive measures which will reduce fleet and field dental emergencies.

a. 6.1 Task Area

Objective: Elucidate the role of hematopoietic cells in the healing of bone.

Criterion Statement:

Knowledge of the role of these cells will lead to procedures which expedite osseous healing and eliminate factors which interfere with the healing process.

Objective: Elucidate the host-rejection phenomenon observed in grafting procedures, to compare the degree of compatibility, with graft-recipients of selected tissue preparations employed as grafts in facial defects.

Criterion Statement:

This study will indicate those graft materials most suitable for clinical treatment of oral and maxillofacial casualties.

Objective: Evaluate treatment methods designed to decrease the healing time and improve success of reconstructive surgery.

Criterion Statement:

Studies will show the effect of acute blood loss on bone graft healing.

b. 6.2 Task Area

Objective: Evaluate methods of treating osteomyelitis in the maxillofacial region.

Criterion Statement:

Studies will show the potential of hyperbaric oxygen for the treatment of mandibular osteomyelitis.

c. 6.3 Task Area

Objective: Evaluate methods of reconstructing lost bone with various bone grafting materials.

Criterion Statement:

The results will identify those graft materials that have the highest degree of predictable success.

Objective: Collect long-term epidemiological data on the rehabilitation of oral and maxillofacial Vietnam War casualties.

Criterion Statement:

Study will identify those treatment procedures that influence and compromise rehabilitation of human casualties.

2. GOAL 2 - Prevention and Treatment of Dental Pulp Disease

Goal 2 is to develop more effective prevention, diagnostic, and treatment methods for pulpal disease to reduce the high incidence of fleet and field dental emergencies.

The program objectives are:

To develop a better understanding of pulp pathology;

To develop means for prevention of pulpal disease; and,

To develop and improve methods of treating pulpal disease.

a. 6.1 Task Area

DSD, NMRI has not current pulp disease studies in the 6.1 task area.

b. 6.2 Task Area

Objective: Develop a reliable material to induce mineralized barrier closure of pulpal exposures.

Criterion Statement:

Study will evaluate various bone graft preparations for potential to induce pulpal healing.

c. 6.3 Task Area

Objective: Evaluate useful materials and treatment procedures for their potential to cause or aggravate pathological conditions of the dental pulp.

Criterion Statement:

The studies will biologically test various restorative materials and treatment adjuncts.

## VI. SUMMARY.

The Oral and Dental Health program has been reviewed from scientific and administrative aspects and has shown tremendous growth in the last few years. Out of a loose accumulation of work units there has grown a strong and vigorous program. It is now highly oriented toward a specific group of dental patients - the active duty Navy and Marine Corps personnel. As the products of research will be implemented through the activities of the Navy Dental Corps, the program is also formed to be relevant to operational requirements of the Navy.

By this Workshop we have had active participation by the investigators in our laboratories with the program manager of NMRDC in defining and planning the program. Those who will execute the program have a finer sense of program management and review, and the program manager is more sensitive to fiscal, personnel, and facilities resources required by the laboratories for their daily activities. Together, the investigators and managers have forged a relevant program, and one which is suitable for audit and review. A definite course is charted to reach strategic objectives and to assure a balance of program related to Naval and Marine Corps requirements.

The program has three main features. First, the operational requirements of naval dentistry deal with preparation of servicemen into a state of combat readiness and care of casualties sustained in naval operations. The Navy and Marine Corps daily gain recruits from civilian life with high prevalence of oral and dental diseases. There are essentially no dental standards for enlistment. Dental caries and periodontal disease are nearly rampant in this population. To support naval dentistry, the research program aims to repair the deformities which are sequelae to oral and dental diseases and to trauma, especially that related to battle.

The second feature is the prevention of oral and dental disease. No other civilian agency or institution deals primarily with prevention in the age groups which military dental officers treat each day. There are just not enough dental officers and auxiliaries to treat all the disease in our active forces. In order to assist naval dentistry get the population it serves into a health maintenance state - the only cost-effective method of health care - the research program must produce preventive measures proven effective in the specific military populations.

Third, there are unique requirements in health care delivery which only our laboratories can evaluate. No other groups deals with a 100,000 new patients each year, has a compelling urgency of fitness in an adult population, or operates in clinics with 100 operatories, or at sea, or with expeditionary forces on a foreign shore.

The total program as stated by this Workshop report is the basis upon which we will develop strategy objectives in dental science and technology and coordinate tri-service planning documents for dental research, development, test and evaluation.



VII TABLES

TABLE 1

LABORATORIES OF THE NAVAL MEDICAL RESEARCH &  
DEVELOPMENT COMMAND

|   |                       |
|---|-----------------------|
| Naval Medical Research Institute (NMRI)             | Bethesda, Maryland    |
| Naval Dental Research Institute (NDRI)              | Great Lakes, Illinois |
| Naval Aerospace Medical Research Laboratory (NAMRL) | Pensacola, Florida    |
| Naval Submarine Medical Research Laboratory (NSMRL) | Groton, Connecticut   |
| Naval Health Research Center (NHRC)                 | San Diego, California |
| Naval Blood Research Laboratory (NMRL)              | Boston, Massachusetts |
| Naval Medical Research Unit #3 (NAMRU-3)            | Cairo, Egypt          |
| Naval Medical Research Unit #2 (NAMRU-2)            | Taipei, Taiwan        |

TABLE 2  
MEDICAL R&D MANPOWER RESOURCES

|                       | AUTHORIZED BILLETS/CEILINGS |           |           |           |           |           |            |
|-----------------------|-----------------------------|-----------|-----------|-----------|-----------|-----------|------------|
|                       | JUN<br>75                   | DEC<br>75 | JUN<br>76 | DEC<br>76 | JUN<br>77 | DEC<br>77 | JUN+<br>78 |
| <u>TYPE PERSONNEL</u> |                             |           |           |           |           |           |            |
| MC/DC OFF             | 85                          | 86        | 87        | 87        | 86        | 79        | 79         |
| MAS OFF               | 93                          | 91        | 90        | 90        | 89        | 88        | 88         |
| HCA OFF               | 28                          | 28        | 26        | 22        | 22        | 21        | 21         |
| TOT OFF*              | 206                         | 205       | 203       | 199       | 197       | 188       | 188        |
| TOT ENL               | 283                         | 284       | 284       | 284       | 302       | 302       | 302        |
| TOT CIV**             | 806                         | 805       | 804       | 787       | 765       | 779       | 779        |
| TOT PERS AUTH         | 1,295                       | 1,294     | 1,291     | 1,270     | 1,264     | 1,269     | 1,269      |
|                       |                             |           |           |           |           |           |            |
| # R&D COMMANDS        |                             | 11        |           | 10        |           | 9         |            |
| # R&D DETACHMENTS     |                             | 3         |           | 3         |           | 3         |            |

\* Excludes a few NC and CEC Officer Billeets

\*\* All direct hire ceilings; slightly more than 30% have been allocated to Foreign National hires; by Dec 77, the civilian ceilings were about 90% filled.

+ Projected; no change expected from Dec 77

TABLE 3  
FY77 YEAR-END AUTHORIZED CIVILIAN GRADE LEVELS

| <u>ACTIVITY**</u> | <u>% BY GRADE LEVEL</u> |                  |                  | <u>(n)</u><br><u>AUTH TOTAL*</u> |
|-------------------|-------------------------|------------------|------------------|----------------------------------|
|                   | <u>WG</u>               | <u>&lt;GS-10</u> | <u>&gt;GS-11</u> |                                  |
| NMRDC             | 05                      | 85               | 10               | 19                               |
| NMRI              | 14                      | 52               | 34               | 225                              |
| NAMRL             | 08                      | 54               | 38               | 121                              |
| NSMRL             | 00                      | 57               | 43               | 58                               |
| NHRC              | 03                      | 55               | 42               | 62                               |
| NDRI              | 12                      | 69               | 19               | 16                               |
| NBRL              | 40                      | 60               | 00               | 10                               |
| NAMRU-3           | 00                      | 00               | 100              | 03                               |
| NAMRU-2           | 00                      | 20               | 80               | 05                               |
|                   | —                       | —                | —                | —                                |
| TOTAL             | 10%                     | 55%              | 35%              | 519                              |

\*U.S. Direct hire ceilings only

\*\*Includes detachments as appropriate



T B L E 4

NAVAL ORAL AND DENTAL HEALTH RESEARCH PROGRAM PERSONNEL

(Allowance (ALL) and On Board (OB) - 1 Jan 78)

| Activity       |     | Officer |    |      | Enlisted  |    | Civilian |    |     | TOTAL |    |
|----------------|-----|---------|----|------|-----------|----|----------|----|-----|-------|----|
|                |     | ALL     | OB |      | ALL       | OB | ALL      | OB |     | ALL   | OB |
| NDRI           | DO  | 8       | 8  | DT   | 13        | 12 |          |    | OFF | 12    | 12 |
|                | MSC | 3       | 8  | HM   | 2         | 2  | 16       | 13 | ENL | 16    | 15 |
|                | VC  | 1       | 1  | USAF | 1         | 1  |          |    | CIV | 16    | 13 |
|                |     | 12      | 12 |      | 16        | 15 | 16       | 13 |     | 44    | 40 |
| NMRI           | DO  | 6       | 6  | DT   | 5         | 5  | 6        | 6  | OFF | 6     | 6  |
|                |     |         |    |      |           |    |          |    | ENL | 5     | 5  |
|                |     |         |    |      |           |    |          |    | CIV | 6     | 6  |
|                |     |         |    |      |           |    |          |    |     | 17    | 17 |
| NNDC           | DO  | 0       | 0  | DT   | 3         | 3  | 1        | 1  | OFF | 1     | 1  |
|                | MSC | 1       | 1  |      |           |    |          |    | ENL | 3     | 3  |
|                |     | 1       | 1  |      |           |    |          |    | CIV | 1     | 1  |
|                |     |         |    |      |           |    |          |    |     | 5     | 5  |
| BUSTAND        | DO  | 1       | 1  |      | 1         | 1  | 0        | 0  | OFF | 1     | 1  |
|                |     |         |    |      |           |    |          |    | ENL | 1     | 1  |
|                |     |         |    |      |           |    |          |    |     | 2     | 2  |
| NMR&DC         | DO  | 1       | 1  |      |           |    |          |    | OFF | 1     | 1  |
| <hr/>          |     |         |    |      |           |    |          |    |     |       |    |
|                |     |         |    |      | ALLOWANCE |    | ON BOARD |    |     |       |    |
| TOTAL OFFICER  |     |         |    |      | 21        |    | 21       |    |     |       |    |
| TOTAL ENLISTED |     |         |    |      | 25        |    | 24       |    |     |       |    |
| TOTAL CIVILIAN |     |         |    |      | 23        |    | 20       |    |     |       |    |
|                |     |         |    |      | 53        |    | 69       |    |     |       |    |

TABLE 5

COMPARISON OF FEDERAL, DOD, NAVY AND RDT&E BUDGETS

FY 1978

|                               | <u>\$ Billions</u> |
|-------------------------------|--------------------|
| Total Federal Budget          | 462.2              |
| Total DOD Budget              | 116.8              |
| DOD Budget for RDT&E          | 11.4               |
| Total Navy Budget             | 39.7               |
| Navy Budget for RDT&E         | 4.0                |
| Navy Budget for Medical RDT&E | 0.037              |

TABLE 6

NAVY MEDICAL RDT&E PROGRAMSFY 78 FUNDS DISTRIBUTION (PROGRAM SIX)

|                          | <u>\$ Millions</u> |
|--------------------------|--------------------|
| Navy Medical R&D Command | 28.8               |
| Office of Naval Research | 6.4                |
| NAVAIR, NAVSUP, NAVELEX  | <u>1.4</u>         |
| TOTAL                    | 36.6               |

TABLE 7

## NMRDC FUNDING BY RDT&amp;E CATEGORY

|                                   | <u>FY 67</u> | <u>FY 69</u> | <u>FY 71</u> | <u>FY 73</u> | <u>FY 75</u> | <u>FY 77</u> | <u>FY 78</u> |
|-----------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 6.1<br>Research                   | 4740         | 5203         | 4734         | 4714         | 4596         | 4959         | 5247         |
| 6.2<br>Exploratory<br>Development | 3178         | 3264         | 4063         | 7121         | 6699         | 8148         | 8740         |
| 6.3<br>Advanced<br>Development    | 1381         | 6315         | 6062         | 7295         | 8270         | 10378        | 10544        |
| 6.4<br>Engineering<br>Development | -            | -            | -            | -            | 743          | -            | -            |
| 6.5<br>Management &<br>Support    | <u>1608</u>  | <u>2566</u>  | <u>3149</u>  | <u>3081</u>  | <u>3577</u>  | <u>6087</u>  | <u>4240</u>  |
| TOTAL                             | 10907        | 17348        | 18008        | 22211        | 23885        | 29572        | 28771        |

(Dollars in K)



TABLE 8

## NMRDC LABORATORY FUNDING\*

|         | <u>FY 72</u> | <u>FY 73</u> | <u>FY 74</u> | <u>FY 75</u> | <u>FY 76</u> | <u>FY 77</u> | <u>FY 78</u> | <u>% CHANGE FY 72-78</u> |
|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------------------|
| NMRI    | 5031         | 4886         | 5117         | 6182         | 9230         | 11923        | 10102        | +101                     |
| NAMRL   | 2036         | 2425         | 2839         | 2904         | 3337         | 3321         | 3799         | + 87                     |
| NSMRL   | 1394         | 1348         | 1385         | 1506         | 1643         | 1742         | 1755         | + 26                     |
| NHRC    | 982          | 916          | 924          | 1142         | 1449         | 1769         | 1760         | + 79                     |
| NBRL    | 331          | 387          | 488          | 656          | 764          | 965          | 872          | +163                     |
| NDRI    | 338          | 329          | 338          | 505          | 522          | 611          | 620          | + 83                     |
| NAMRU-2 | 1492         | 1486         | 1604         | 1659         | 1830         | 1874         | 1748         | + 17                     |
| NAMRU-3 | 758          | 672          | 692          | 502          | 515          | 614          | 692          | - 9                      |

(Dollars in K)

\*Exclusive of reimbursables and PL-480 funds

TABLE 9

## DISTRIBUTION OF FY 1978 NMRDC FUNDS BY PROGRAM

|                           | IN-HOUSE WORK UNITS |        | OUT-OF-HOUSE EFFORTS |       | TOTAL |        |
|---------------------------|---------------------|--------|----------------------|-------|-------|--------|
|                           | NO.                 | \$K    | NO.                  | \$K   | NO.   | \$K    |
| Fleet Health Care         | 65                  | 4,537  | 21                   | 1,568 | 86    | 6,105  |
| Submarine/Diving          | 65                  | 3,920  | 25                   | 1,809 | 90    | 5,729  |
| Infectious Diseases       | 52                  | 3,124  | 7                    | 457   | 59    | 3,581  |
| Aviation Medicine         | 15                  | 2,884  | -                    | -     | 15    | 2,884  |
| Occupational Health       | 18                  | 1,444  | 10                   | 425   | 28    | 1,869  |
| Human Performance         | 30                  | 1,773  | 2                    | 50    | 32    | 1,823  |
| Electromagnetic Radiation | 15                  | 1,001  | 10                   | 480   | 25    | 1,481  |
| Oral & Dental Health      | 15                  | 614    | 2                    | 40    | 17    | 654    |
|                           | -                   | -      | -                    | -     | -     | -      |
| TOTAL                     | 275                 | 19,297 | 77                   | 4,829 | 352   | 24,126 |

TABLE 10

## NMRDC PROGRAM FUNDING TRENDS; FY 72 - 78

|                           | FY 72  | FY 73  | FY 74  | FY 75  | FY 76  | FY 77  | FY 78  | %Change FY 72-78 |
|---------------------------|--------|--------|--------|--------|--------|--------|--------|------------------|
| Fleet Health Care         | 4,366  | 4,168  | 5,551  | 5,064  | 5,279  | 5,557  | 6,105  | +40              |
| Submarine & Diving        | 3,882  | 4,261  | 4,250  | 4,417  | 4,796  | 5,710  | 5,729  | +48              |
| Infectious Disease        | 3,211  | 2,799  | 3,071  | 2,985  | 3,339  | 3,449  | 3,581  | +11              |
| Aviation                  | 1,233  | 1,640  | 1,860  | 2,034  | 2,151  | 2,519  | 2,884  | +134             |
| Fleet Occupational Health | 944    | 823    | 1,146  | 1,419  | 1,646  | 1,779  | 1,869  | +98              |
| Human Performance         | 2,074  | 2,177  | 1,917  | 1,840  | 1,876  | 1,921  | 1,823  | -12              |
| EMR                       | 1,397  | 1,570  | 1,451  | 1,335  | 1,558  | 1,541  | 1,481  | +06              |
| Dental Health             | 559    | 607    | 564    | 665    | 694    | 589    | 654    | +17              |
| TOTAL                     | 17,666 | 18,045 | 19,810 | 19,759 | 21,339 | 23,065 | 24,126 | +37              |
| All Other Funds*          | 4,191  | 4,166  | 3,755  | 4,126  | 5,648  | 6,507  | 4,645  | +11              |
| GRAND TOTAL               | 21,857 | 22,211 | 23,565 | 23,885 | 26,987 | 29,572 | 28,771 | +32              |

(Dollars in K)

\*Independent Research, Management and Support, Studies and Analysis

TABLE 11

## FY 78 ODH ALLOCATIONS (1 JANUARY 1978 )

|                      | NMRI | NDRI | BUSTAN | NNDC | TOTAL |
|----------------------|------|------|--------|------|-------|
| 6.1                  | 215  | 49   | 20     | 20   | 304   |
| 6.2                  | 40   | 163  | -      | -    | 203   |
| 6.3                  | 86   | 98   | -      | -    | 184   |
| Independent Research | 5    | 30   | -      | -    | 35    |
| 6.5                  | -    | 280  | -      | -    | 280   |
| TOTAL                | 346  | 620  | 20     | 20   | 1,006 |

(Dollars in K)



TABLE 12  
DENTAL PROFILE OF NAVAL RECRUITS  
AT GREAT LAKES, 1976

|                                  |       |
|----------------------------------|-------|
| Decayed Teeth                    | 5.4   |
| Missing Teeth                    | 0.6   |
| Restored Teeth                   | 6.7   |
| DMFT                             | 10.7  |
| Navy Periodontal Disease Index   | 6/19  |
| Navy Plaque Index                | 17/85 |
| Calculus Surface Index(modified) | 9.2   |

TABLE 13

INITIAL PROJECTED TREATMENT

PER 1000 NAVAL RECRUITS AT GREAT LAKES

|                                |              |
|--------------------------------|--------------|
| Operative and Crown and Bridge |              |
| Amalgam (one surface)          | 3,161        |
| Amalgam (two or more surfaces) | 2,752        |
| Root canal filling             | 83           |
| Bridge                         | 4            |
| Crown                          | 28           |
| Prosthodontics                 |              |
| Full denture                   | 0            |
| Partial denture                | 31           |
| Oral Surgery                   |              |
| Root, residual removal         | 118          |
| Tooth removal                  | 374          |
| Periodontics and Oral Hygiene  |              |
| Gingivectomy                   | 16           |
| Prophylaxis                    | 996          |
| Scaling (periodontal)          | 728          |
| Caries Prevention Treatments   | 2,000        |
| Plaque Control Instruction     | 4,744        |
| Examination                    |              |
| Examinations and Consults      | 1,815        |
| X-rays                         | 4,224        |
| Miscellaneous                  | <u>7,611</u> |
| TOTAL                          | 28,685       |

TABLE 14

## ORAL AND DENTAL HEALTH RESEARCH PROGRAM TRAINING REQUIREMENTS

FY 1979 - FY 1985

| FIELD                            | SUBPROGRAM TO BE SUPPORTED                           | TYPE AND LENGTH OF TRAINING   | SUMMER OF COMPLETION                     |
|----------------------------------|--|---|--|
| General                          | General  | Fellowship, 1 year with approved extension to 2 years (1 or 2 per year x 4 years) | 1 in 80<br>1 in 81<br>1 in 82<br>1 in 83 |
| Biochemistry (DDS)               | Oral Disease Prevention, Pulp Biology                | PhD, 3 years  | 1 in 1982                                |
| Microbiology (MSC)               | Oral Disease Prevention, Battle Injury               | PhD, 3 years  | 1 in 1982                                |
| Immunology (DDS)                 | Battle Injury, Oral Disease Prevention               | PhD, 3 years  | 1 in 1983                                |
| Microanatomy (DDS)               | Oral Disease Prevention, Pulp Biology, Battle Injury | PhD, 3 years  | 1 in 1984                                |
| Physiology (DDS)                 | Battle Injury, Pulp Biology                          | PhD, 3 years  | 1 in 1985                                |
| Epidemiology-Public Health (DDS) | Oral Health Care Delivery                            | PhD, 2 years  | 1 in 1985                                |
| Microbiology (MSC)               | Oral Disease Prevention                              | PhD, 3 years  | 1 in 1985                                |

TABLE 15

## FUNDING OF DENTAL SCIENCES DEPARTMENT, NMRI

| FISCAL YEAR | DEPT ORGANIZATION                         | \$ in K<br>FUNDING | \$ in K<br>EQUIPMENT | No. 1498's |
|-------------|---|--------------------|----------------------|------------|
| 1973        | 1) BIOCHEMICAL BACTERIOLOGY<br>DIVISION   | 264.4              | 29.0                 | TOTAL - 8  |
|             |   | 6.1 - 134          | NO MINOR RENOVATION  | 6.1 - 3    |
|             | 2) PERIODONTOLOGY DIVISION                | 6.2 - 93           |                      | 6.2 - 3    |
|             |   | 6.3 - 19.4         |                      | 6.3 - 2    |
|             | 3) ORAL/MAXILLOFACIAL<br>SURGERY DIVISION |                    |                      |            |
| 1974        | SAME AS ABOVE                             | 253.0              | 21.0                 | TOTAL - 8  |
|             |   | 6.1 - 113          | NO MINOR RENOVATION  | 6.1 - 3    |
|             |   | 6.3 - 100          |                      | 6.2 - 3    |
|             |   | 6.3 - 40           |                      | 6.3 - 2    |
| 1975        | SAME AS ABOVE                             | 336.8              | 15.0                 | TOTAL - 12 |
|             |   | 6.1 - 182          | NO MINOR RENOVATION  | 6.1 - 5    |
|             |   | 6.2 - 84           |                      | 6.2 - 3    |
|             |   | 6.3 - 62.8         |                      | 6.3 - 2    |
|             |   | IR - 8.0           |                      | IR - 2     |
| 1976        | SAME AS ABOVE                             | 396.2              | 10.0                 | TOTAL - 15 |
|             |   | 6.1 - 193          | NO MINOR RENOVATION  | 6.1 - 6    |
|             |   | 6.2 - 74           |                      | 6.2 - 3    |
|             |   | 6.3 - 102.2        |                      | 6.3 - 2    |
|             |   | IR - 13            |                      | IR - 3     |
|             |   | ONR - 14           |                      | ONR - 1    |
| 1977        | 1) LABORATORY SCIENCES<br>DIVISION        | 300.1              | 3.7                  | TOTAL - 8  |
|             |   |                    | RENOVATION:          |            |
|             |   | 6.1 - 175          | Room #151            | 6.3 - 3    |
|             |   | 6.2 - 40           | Room #153A           | 6.2 - 1    |
|             |   | 6.3 - 82.6         | Room #147A           | 6.3 - 3    |
|             | 2) CLINICAL SCIENCES<br>DIVISION          | IR - 2.5           |                      | IR - 1     |
| 1978        | SAME AS ABOVE                             | 349.3              |                      | TOTAL - 9  |
|             |   | 6.1 - 214          |                      | 6.1 - 3    |
|             |   | 6.2 - 40           |                      | 6.2 - 1    |
|             |   | 6.3 - 90           |                      | 6.3 - 3    |
|             |   | IR - 5             |                      | IR - 2     |



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